MINES AND MINERAL RESOURCES OF SHASTA COUNTY, CALIFORNIA

COUNTY REPORT 6

CALIFORNIA DIVISION OF MINES AND GEOLOGY

Mines and Mineral Resources of

SHASTA COUNTY

California

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COUNTY REPORT 6

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THE RESOURCES AGENCY
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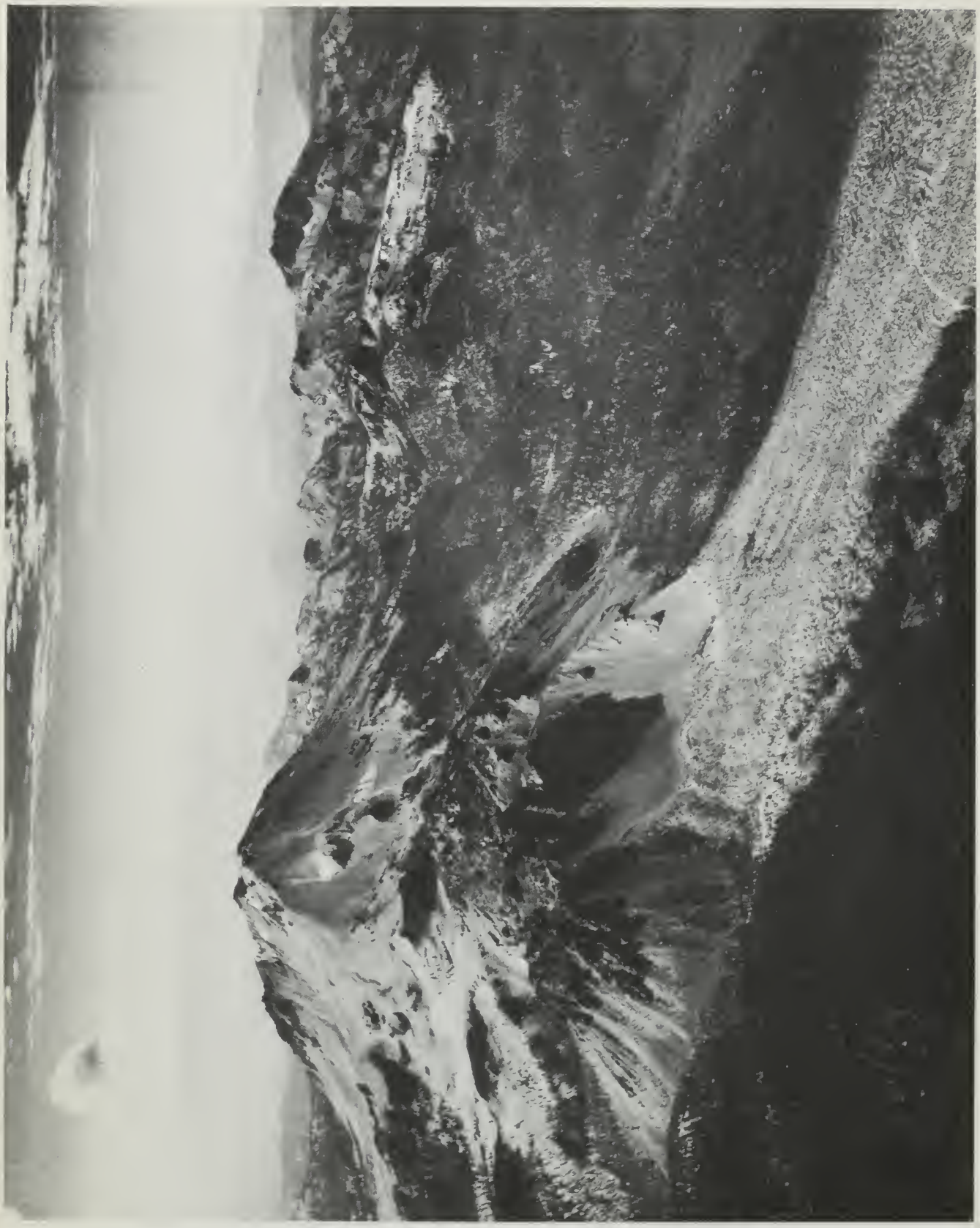

Photo 1. View southword toward Lassen Peok, showing Chaos Crogs (lower left middleground), ond other features of Lossen Volconic Notionol Pork. Brakeoff Mtn. and Mt. Diller are remnants of on extensive Pleistocene volcana, naw largely eroded. Pleistocene dacite domes make up Morgan and Doe Mountains, and Eagle and Lossen Peoks; Chaos Crags are composed of Holocene dacite domes. Choos Jumbles (light band, right foreground) is a volcanic mudflow that originated from collapse of part of Chaos Crags (note concave scor ot heod of Jumbles), probably about 1690, as doted by count of tree rings. Photo by J. S. Shelton, 1959.

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Cover designed and drawn by Ed Foster

ABSTRACT

Shasta County, comprising almost 2.5 million acres, is at the northern end of the Great Valley of California. The eastern part of the county consists of an upland marked by fault-tilted ridges and isolated volcanic peaks. Lassen Peak near the southeastern corner attains the highest elevation in the county, 10,457 feet. The northwestern part of the county consists of rugged peaks and ridges incised by the steep canyons of the Sacramento River and its major tributaries, whereas the southwestern portion is characterized by the low, rolling hills and flat bottomlands of the Great Valley and adjacent foothills of the Coast Ranges.

A population of 77,123 (U.S. census 1970 preliminary) is concentrated largely in the Redding-Enterprise, Shasta Dam, and Anderson-Cottonwood areas. Two towns in the county are incorporated, including Redding, the county seat, and only eight have estimated populations in excess of 700.

Shasta County embraces portions of five geomorphic provinces that fall into three broad groupings of rocks with common origins: metamorphic and intrusive rocks of the Klamath Mountains, sedimentary rocks associated with the Great Valley and Coast Ranges, and the volcanic terrane of the Cascade Range and Modoc Plateau.

Rocks of the Klamath Mountains range from pre-Middle Devonian to latest Jurassic in age. A thick sequence of alternating metavolcanic and metasedimentary rocks has been regionally deformed, broken by several major, north- or northwest-trending faults, and intruded by masses of ultramafic and granitic rock. Mineralization associated with the Jurassic orogeny has yielded base-metal and pyritic deposits that were mined in the East Shasta and West Shasta copper-zinc districts, lode-gold deposits in the French Gulch, Old Diggings, Shasta, and Whiskeytown districts, and silver deposits in the South Fork district. Other mineral commodities in the Klamath Mountains include chromite, iron, manganese, molybdenite, platinum, tungsten, asbestos, barite, limestone, olivine, sand and gravel, dimension and crushed stone, and talc.

Sedimentary rocks associated with the Great Valley and Coast Ranges include slightly deformed marine sediments of Early and Late Cretaceous ages, and continental sediments of Eocene, Pliocene, Pleistocene, and Holocene ages. Mineral resources yielded by these rocks include placer deposits containing gold, silver, and minor platinum, sand and gravel, crushed and dimension stone, clay, coal, and water. Prospecting for natural gas has thus far failed to locate commercial deposits.

Volcanic and associated sedimentary rocks of the Cascade Range and Modoc Plateau range from Pliocene to Holocene in age. Mineral resources include pumice, volcanic cinders, sand and gravel, crushed and decorative stone, and diatomite from former basins of interior drainage.

The value of mineral production in Shasta County—$5,944,064 in 1969—was exceeded by the values of retail sales, wholesale receipts, cut timber, and agricultural products.

Shasta County was established in 1850, two years after Pierson B. Reading discovered gold in the area. Its original extent of about 20,000 square miles was reduced by later State legislatures. Lode gold was discovered near French Gulch in 1852, and gold production dominated the mineral economy of the county until 1897. Copper was first mined in 1865, but not until 1896 did mining of this metal become important. For each of the following 23 years, the value of copper production accounted for more than half—and often more than three-quarters—of the annual mineral production for the county. No mineral commodity again dominated the mineral economy of Shasta County

until increased public-works construction during the 1950's and 1960's moved sand and gravel into a position of pre-eminence. Beginning with 1962, quarrying of limestone and production of cement in a newly constructed cement plant made those mineral commodities the principal ones in the county.

Fourteen metallic and 17 nonmetallic mineral commodities are discussed in this report. The historically important or larger, recently active properties are described in some detail. A tabulated list presents condensed descriptions and pertinent references to the technical literature for several hundred mines and prospects. The geology of the geomorphic provinces and the historical geology of the entire county are described, based on the wealth of geological information made available in recent years.

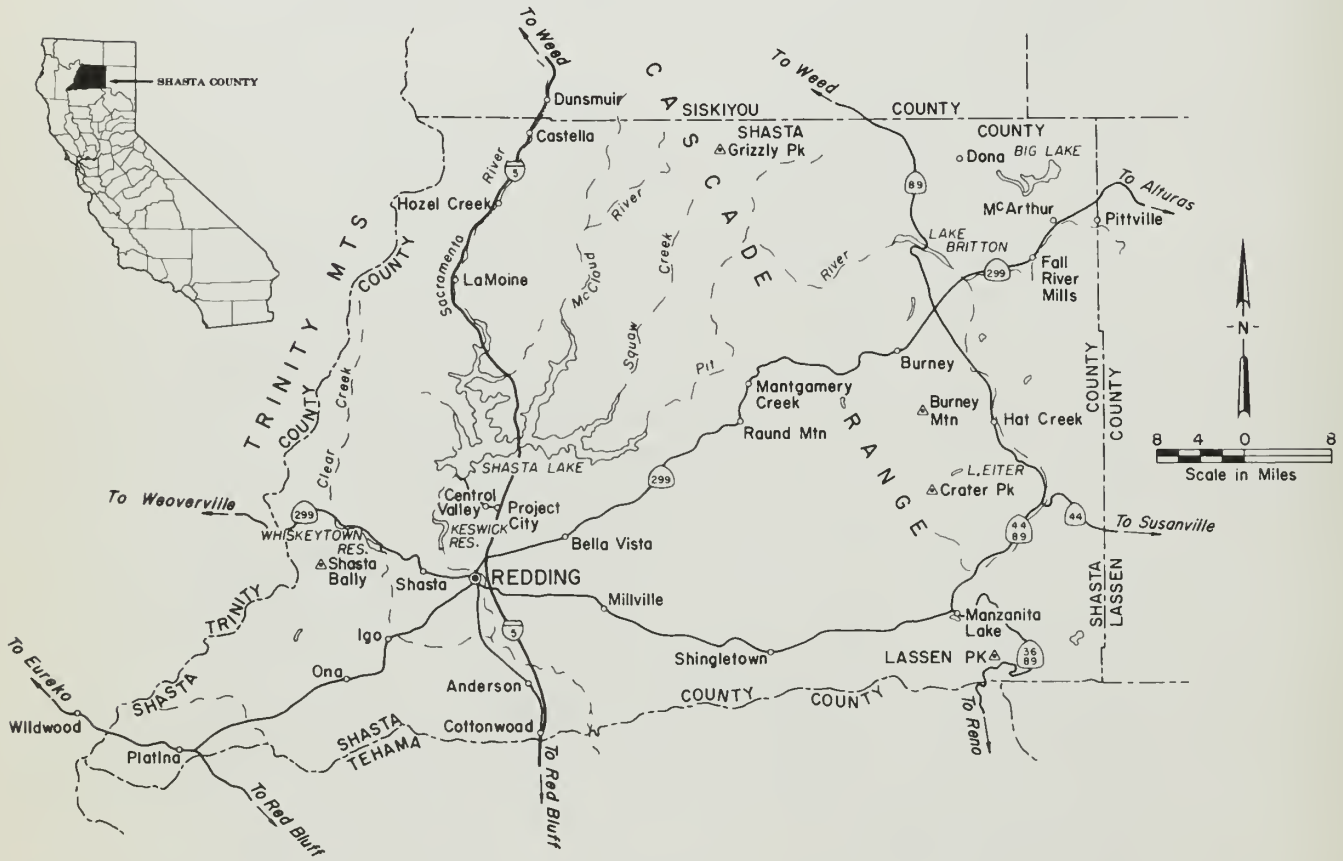


Figure 1. Index map showing principal geographic features and location of Shasta County.

MINES AND MINERAL RESOURCES OF SHASTA COUNTY, CALIFORNIA

By PHILIP A. LYDON and J. C. O'BRIEN

Introduction

Geography

Shasta County is situated at the northern end of the Great Valley of California, about 235 miles north of San Francisco. It is bounded on the north by Siskiyou and a portion of Modoc Counties, on the east by Lassen County, on the south by Tehama and a portion of Plumas Counties, and on the west by Trinity County. The county is contained principally within the Klamath Mountains and Cascade Range geomorphic provinces, but parts of it also are included in the Modoc Plateau, Great Valley, and Coast Ranges provinces.

Elevations range from about 400 feet near Cottonwood to 10,457 feet at Lassen Peak. West, north, and northeast of Redding, the county is characterized by rugged peaks and ridges incised by the steep canyons of Squaw Creek and the Sacramento, McCloud, and Pit Rivers. The eastern portion of Shasta County consists of an upland marked by isolated volcanic peaks and fault-tilted ridges. Southwest and southeast of Redding are the low, rolling hills and flat bottomlands typical of the Great Valley and the foothills of the Coast Ranges.

The western part of the county is cut by the southward-flowing Sacramento River. All the major streams in Shasta County—Squaw, Clear, Cow, Cottonwood, and Battle Creeks and the Pit and McCloud Rivers—are tributary to the Sacramento River. Other lesser streams, such as Clover, Bear, and Hat Creeks and Fall River, are in turn tributary to these. Big Lake, Lake Britton, Shasta Lake, and Whiskeytown Lake are the principal bodies of water in Shasta County; all have been impounded for irrigation or flood-control purposes. Water from the Trinity River was released into the new Whiskeytown Lake beginning in May 1963.

Shasta Dam, situated on the Sacramento River about 12 miles north of Redding, is one of the largest concrete structures ever built. Its construction required 12 million tons of aggregate and 6.8 million barrels of cement. It is 602 feet high, approximately 3,500 feet long, and impounds 4,500,000 acre feet of water within the canyons of the Sacramento, Pit, and McCloud Rivers; the lake thus formed has a shoreline 365 miles long.

The 1970 census reported a population of 77,123 for Shasta County, an increase of 30 percent over the 1960 figure. Approximately 85 percent of the county's population lives in the Redding-Enterprise, Shasta Dam, and Anderson-Cottonwood areas. Redding, the county seat, has a population of 16,365, while Anderson has a population of 5,442 (1970). Redding is one of the leading mining, lumbering, shopping, construction, and tourist recreation centers of northern California. The other principal towns in Shasta County, with estimated populations ranging from about 700 to 2,500 are Buckeye, Burney, Castella, Central Valley, Cottonwood, and Enterprise. Towns with populations ranging from about 100 to 700 include Fall River Mills, French Gulch, Ingot, Matheson, McArthur, Millville, Montgomery Creek, Olinda, Project City, Round Mountain, Shasta, Shingletown, Summit City, Toyon, and Whitmore.

The county road system includes about 300 miles of state highway, 1,100 miles of maintained county roads, and 360 miles of primary county roads. The main line of the Southern Pacific Railway and U. S. Highway 99 follow the Sacramento River northward through the western part of the county. Highway 299 crosses the county east and west from Redding; Highway 44 extends east from Highway 99 to Lassen Volcanic National Park and beyond to the eastern county line; Highway 89 extends northward in the eastern part of the county, connecting the Lassen Peak and Mount Shasta regions.

Variations of climate within Shasta County are governed principally by elevation, ranging from hot summers and mild winters in the valley area to cool summers and cold winters in the mountains. Precipitation also varies widely, from 16 inches in the eastern part of the county to more than 70 inches near Castella. At Redding, the average monthly precipitation exceeds four inches November through March, reaching a peak of more than seven inches in January.

INDUSTRIES

Shasta County comprises almost 2.5 million acres; major land uses include 1.3 million acres of private and public commercial forest land, 525,000 acres of grassland, 58,000 acres of cropland, and 790,000 acres in farms. The Federal Government owns about 40 percent of the land in Shasta County. (California State Chamber of Commerce, 1958; Redding Chamber of Commerce, personal communication, May 1963).

Mineral production in the county was valued at $5,944,064 for 1969. Other major economic categories include cut timber ($95 million, 1961) and, in previous years, wholesale receipts ($36 million, 1954), value added by manufacture ($25 million, 1954), and service

Phata 2. The cataclysmic eruption of Lassen Peak on May 22, 1915, produced a towering column of volcanic ash clearly visible more than a hundred miles away. This photograph was taken by B. F. Laomis from Andersan, 42 miles distant. The asymmetrical cinder cone of Black Butte on Shingletown Ridge is silhouetted in the middle distance.

trades receipts ($7 million, 1954). (California State Chamber of Commerce, 1958; Shasta County Economic Commission, personal communication, May 1963.)

Shasta County has numerous advantages to offer industry, among which are abundant land, cheap electrical power, equable climate, availability of natural gas, adequate supplies of water, and ready access to principal routes of transportation.

In addition to these, Shasta County also has the advantages of scenic resources and recreation facilities that annually attract tens of thousands of visitors. Improved and unimproved campsites are maintained by the U. S. Forest Service in the Shasta-Trinity and Lassen National Forests and by the U. S. National Park Service in Lassen Volcanic National Park. State parks and camping facilities are maintained at Burney Falls and Castle Crags. Commercial resorts or motels are situated along the Sacramento River, at Shasta Lake, and in most towns and settlements in the county. Fishing, hunting, hiking, skiing, and water-skiing are other pursuits to which the area is well adapted.

Among the well-known scenic spots of Shasta County are Lassen Peak, Hat Creek Valley, Burney Falls, Shasta Lake, and Castle Crags; other attractive and beautiful spots are to be found along countless trails and secondary roads, and in the pathless, rugged terrain that remains in the Klamath Mountains and Cascade Range.

History

Gold was first discovered in Shasta County on Clear Creek in 1848 by Major Pierson B. Reading, who had passed through the region with the Chiles expedition in 1843, returned as a settler in 1845, and built in 1847 an adobe that still stands. Gold then was discovered near the present site of Shasta, and a small settlement grew up there under the name of Reading Springs.

Shasta County was created February 18, 1850, as one of the original 27 counties of California. At that time it covered about 20,000 square miles, but portions subsequently were assigned to Lassen, Siskiyou, and Tehama Counties. The derivation of the name "Shasta" is in doubt. Some claim it was derived from Shas-ti-ka, the name of a tribe of Indians that lived at the base of Mount Shasta. Others claim that "Shasta" is a corruption of the French word "chaste," first applied by explorers because of the whiteness or chastity of the snow that caps Mount Shasta. When Siskiyou County was organized in 1852, the portion of Shasta County that contained Mount Shasta was included within its boundaries. When Lassen County was created April 1, 1864, however, Lassen Peak (then called "Lassen's Butte") was left within Shasta County.

The name of Reading Springs was changed to Shasta four months after the county was created, and in 1851 the seat of county government was moved there from Reading's ranch. The small gold rush that followed the various discoveries of gold in Shasta County resulted then and in succeeding decades in the establishment of numerous small towns, among them Newtown, Lower Springs, Canon Bottom, Horsetown, Middletown, Briggsville, Copper City, Hogtown, and Poverty Flat (later Redding).

In 1852, gold was discovered in veins at the Washington mine in the French Gulch district. Although the first mining of lode gold in California is variously credited by historians to the Mariposa vein in the summer of 1849 or to an anonymous German near Nevada City in September 1850, the Washington mine nonetheless ranks among the oldest lode locations in the state.

The existence of potentially valuable deposits of copper in Shasta County was noted publicly as early as 1859, but in spite of this, and in spite of the discovery of copper in Calaveras County in 1860 and the speculative boom that followed, copper was not mined in Shasta County until 1865. Placer gold had been found near Bully Hill in 1853, and resulting activity in the area led nine years later to the discovery of lode gold deposits near the future site of Copper City. Shortly thereafter copper deposits were discovered at Bully Hill and near the site of Furnaceville (later Ingot). The copper occurred in "base" or sulfide ores, however, and efforts to process them efficiently met with little success until near the turn of the century.

Construction of the California-Oregon Railroad between the 1860's and 1880's changed the economic pattern in the county. Shasta, the county seat, had been the center of trade and the focal point of transportation for two decades because of its position astride the natural routes of transportation to Trinity and Siskiyou Counties and from Reno (whence came the well-known Noble Trail) and Sacramento. But when the rails were being laid toward Redding, following the gentle grade demanded by the engineers, Shasta was 500 feet too high and the prized position of railroad terminus fell to Redding. The town, incidentally, was named after B. B. Redding, a land agent of the Central Pacific Railroad, and not after Major Reading, whose name was pronounced identically. The first passenger train arrived in Redding in September 1872, and for 11 years the town was at the "end of the line." It in turn became the center of trade in the county, and Shasta gradually slipped from its position of prominence. Redding was incorporated in 1887 and became the county seat the following year.

The extensive gossan at Iron Mountain had been known since the early 1860's when William Magee and Charles Camden located it as an iron mine, but it was not until James Sallee discovered silver nearby in 1879 or 1880 that it became the object of widespread interest. A short-lived silver boom resulted, but Magee, Camden, and Sallee, now partners, continued to hold their claims. Fourteen years later the property was sold to a group of British financiers. Subsequently it was acquired by the Mountain Copper Company, and mining of copper began in 1896.

The following 23 years were the greatest period of prosperity in mining that Shasta County had enjoyed since—and probably even including—the early years of the gold rush. In 1875, C. M. Peck had built a reverberatory furnace to process ore from the Copper Hill mine (later named Afterthought), but it and other

small furnaces subsequently built there were failures in treating the complex ores. The smelter of the Mountain Copper Company, operated at Kennett from 1896 to 1907, thus was the first successful smelter in Shasta County. The success of this company did much to stimulate exploration and development of other mines in the West Shasta and East Shasta copper belts. Another smelter was operated at Bully Hill (Winthrop) from 1901 to 1910; ore from the Balaklala mine was smelted at Coram near Shasta Dam from 1906 to 1911; the U. S. Smelting, Refining and Mining Company operated a smelter at Keswick during 1907–1919 and 1924; and at the Afterthought mine, a blast furnace was used during 1905–1908 and a reverberatory furnace during 1919–1920.

Activity at the copper mines and the need for smelting fluxes caused a brief resurgence in gold mining in the Shasta, Whiskeytown, and Old Diggings districts. The smelters paid several dollars per ton for quartz and in addition paid for the gold content of the sub-marginal ores that were used for this purpose. During this same time, limestone was being quarried locally, also for use in the smelters; in 1898, for example, the firm of J. R. Holt and J. N. Gregg employed 25 men at their Kennett quarry, supplying 70 tons of limestone daily to the Mountain Copper Company smelter.

Acrimonious fumes from the smelters eventually resulted in litigation aimed at the curtailment of their activities; this turn of events, together with the increasingly high content of refractory zinc encountered in many of the ores, brought about the decline of smelting.

Around the turn of the century, Shasta County had at least nine newspapers, including the Shasta Courier, Anderson Valley News (formerly Anderson Enterprise), Copper City Pioneer, Mountain Miner, The Searchlight, Millville Tidings (formerly East Side Times), Fall River Tidings, Free Press, and Shasta County Democrat. In succeeding years, several papers were absorbed by their competitors, some simply failed, and others passed through various hands and survived to the present day; four papers are now published in the county.

Although gold and copper provided the greatest mining prosperity for the county, other mineral commodities also are of historical importance. Pyrite was first treated shortly after the turn of the century for by-product recovery of sulfur. A short-lived petroleum excitement around the same time resulted in the drilling of a few dry holes, and chromite and iron ore—both first mined in 1894—were produced more or less continuously until after World War I. The chromite came principally from the Little Castle Creek mine, and the iron ore came from the Shasta and California mines. An electric-arc smelter was built by the Noble Electric Steel Company in 1907 at Heroult, near the junction of the Pit and McCloud Rivers; pig iron was produced here until 1914, and then ferromanganese and ferrosilicon until the end of the war.

Gas for street lights and heating in commercial places of business was manufactured in Redding from crude oil as early as 1886, when the Redding Gas Company began operations. By 1898 approximately 51 million cubic feet of gas were being manufactured annually. Facilities of the gas company were sold that year, and during the succeeding three decades they numbered among their owners the Redding Electrical Power Company, the Keswick Electrical Power Company, and the Northern California Power Company. Water had been used locally to generate electricity several years before 1900; in that year the Northern California Power Company Consolidated was organized, and by 1914 there were seven powerhouses in the county with a total capacity of 54,600 hp. The company and its holdings were acquired by Pacific Gas and Electric Company in 1919.

During the interval between World Wars, the economy of Shasta County became more diversified, with substantially less dependence on mining. Lumbering, agriculture, manufacturing, and trade all increased in importance.

It was during this time that the first important efforts were made to recover zinc from the complex ores that hitherto had yielded principally copper and gold. A flotation plant at Bully Hill successfully treated high-grade zinc ore from the Bully Hill and Afterthought mines from 1921 to 1927. In later years, zinc concentrates were recovered at the Iron Mountain (1943–1947) and Afterthought (1948–1952) mines.

Gold mining was curtailed during World War II, but once again chromite, manganese ore, and iron ore were mined. It was during this time, too, that Shasta Dam was constructed. As a consequence, the value of mineral production in the county exceeded four million dollars in 1942, the highest amount recorded during the 18 years preceding and for 19 years following.

Gold mining resumed in mid-1945, reached a peak value the next year, and has declined steadily ever since. In recent years, most of the value of mineral production in the county has been attributable to sand and gravel and pyrite. Increases in normal building construction, coupled with large-scale public works (state freeways; dams and appurtenant works of the Trinity River Project) in the county accounted for much of this. In 1962, Calaveras Cement Company operated its new cement plant during the entire year, and limestone and cement became dominant in the mineral economy of the county. Beginning that same year, Pacific Gas and Electric Company started construction of a system of dams and tunnels on the McCloud and Pit Rivers for hydroelectric purposes. This was the same year, too, that Mountain Copper Company closed down its pyrite mine, after almost seven decades of continuous operation at Iron Mountain.

Scope and Preparation of Report

This report provides a summary of available information on mining in Shasta County. Particular attention is paid to properties that have been historically important producers or that were active since 1939, the date of the last comprehensive report on the mines of the county (Averill, 1939). In addition, the regional geology and its relationship to mineral deposits are

discussed, and production trends up to 1965 are reviewed briefly for each of 29 mineral commodities.

Preparation of this report was started by the junior author in 1953 and a rough draft was completed in 1956. Revisions were made in the text and tabulated list during succeeding months, including a re-check of ownerships in the county records, and the revised manuscript was submitted in September 1958. Mr. O'Brien retired in October 1959 after 27 years of continuous service with the Division of Mines. The report was assigned to the senior author in 1961 for revision and rewriting. During the following two and one-half years, he visited more than 125 mines and mineral deposits. The tabulated list was rewritten, and the text was rewritten and enlarged more than twice in size. Special attention was paid to the wealth of geological information on the county appearing in the literature since 1956, and discussions of the mines and mineral resources rely heavily on their relation to geology. Ownership records were brought up to date only for the more extensive properties, or for properties on which significant activity occurred during 1961–1963. The report was submitted in May 1964. Following a leave of absence of two years, the senior author made minor revisions in early 1967, and mineral production figures are updated to 1970.

The authors wish to thank the many mine owners without whose cooperation this report could not have been written. For information and assistance we also are indebted to W. J. Walker, consulting mining engineer; J. F. Harrigan, assayer; J. T. Curry, Calaveras Cement Company Division of Flintkote Company; and D. K. Winsor, Mountain Copper Company of California; all of Redding. The courteous help offered by employees of the State Division of Highways, District II, and the office of the Shasta County Recorder did much to facilitate preparation of the report. Assistance also was obtained from F. F. Davis, J. R. Evans, T. E. Gay, Jr., H. B. Goldman, S. J. Rice, R. M. Stewart, and F. H. Weber, Jr., all geologists of the Division of Mines and Geology.

Geology

Shasta County contains portions of five of the 11 geomorphic provinces into which California is divided. These five provinces fall into three groupings of rock types that, broadly speaking, have common origins: the metamorphic and intrusive rocks of the Klamath Mountains, ranging from pre-Middle Devonian to latest Jurassic in age; sedimentary rocks associated with the Great Valley, ranging from Early Cretaceous to Pleistocene; and the volcanic terrane of the Cascade Range and Modoc Plateau in the eastern part of the county, late Tertiary to Holocene in age.

Those geological events that have created the diverse lithologies and structures present in the rocks of Shasta County are considered briefly in the next section, followed by a discussion in some detail of the geology of each of the geomorphic provinces.

Comprehensive reviews of the current state of geological knowledge in each of the geomorphic provinces included in Shasta County are contained in a series of articles appearing in Division of Mines and Geology Bulletin 190, "Geology of northern California" (Bailey, 1966).

Geological History

The beginnings of geological history in Shasta County are attended by considerable uncertainty. Metamorphosed volcanic and sedimentary rocks (Salmon and Abrams Formations) of the central metamorphic belt (Irwin, 1960) of the Klamath province have long been considered the oldest rocks in Shasta County, a belief founded on the obviously greater metamorphism to which these rocks have been subjected. However, inasmuch as no fossils have been found in them, their age and relationship to the oldest rocks in the county whose age is reasonably well established must remain a matter of conjecture. Likewise, the cherts, schists, slates, and quartzites (Chanchelulla Formation) of the western Paleozoic belt bear an uncertain genetic relationship to rocks of known age. The Chanchelulla Formation has yielded Permian fossils in Trinity County, but it is separated from the nearest Permian rocks in Shasta County by the central metamorphic belt and a distance of more than 30 miles. Thus, an orderly sketch of the geological history of Shasta County must, for the moment, pass over these two belts of rock, admitting that their meaning and significance in the geological story are unknown.

The known geologic history begins, then, in Early or Middle Devonian time, when volcanic activity started at many widely scattered points, and flows and tuffs were deposited—principally under water—in an area, largely north of the present sites of Redding and Lewiston, comprising more than a thousand square miles. The succession of flows and tuffs (Copley Greenstone) is relatively thin when its widespread distribution is taken into account; for this reason, and because individual flows rarely can be traced as much as a mile, there must have been a considerable number of volcanic vents.

Some of these vents began to extrude rhyolitic material at the same time that others nearby were still extruding mafic flows and pyroclastic ejecta. This condition did not last, however, and soon only rhyolitic material (Balaklala Rhyolite) was being erupted. Most of these rocks were emplaced under water, although some quite definitely were deposited on land. Balaklala volcanism was more restricted than that of the Copley, and it gradually built up a broad, elongate volcanic pile 16 miles long, three miles wide, and 3,500 feet thick, extending southwestward from the present site of Backbone Creek.

Although the ocean basin in which the products of volcanism were accumulating must have been actively subsiding at the same time, enough volcanic rock was deposited to form a broad submerged ridge capped by complex volcanic cones that extended above water as scattered islands. Along the eastern edge of the submerged highland were deposited black, siliceous shale and chert of the Middle to Late(?) Devonian Kennett Formation; probably some of the silica in these sediments originated from continuing volcanic activity, a view supported by the occurrence of interbeds of Balaklala Rhyolite in the lower part of the Kennett. The upper part of the Kennett Formation consists of coral limestone 250 feet thick and must have formed as reefs under shallow water conditions.

Following deposition of the Kennett, the region was moderately warped, and Kennett sediments in the East Shasta district were locally stripped by erosion; in the West Shasta district, however, the basin received continuous sedimentation lasting into the Mississippian Period. The eastern, uplifted part of the basin then subsided rapidly, and received several thousand feet of mud, silt, and gravel (Bragdon Formation) contemporaneously with similar sedimentation in the moderately deep water of the western part of the basin. Conditions of deposition north of these areas is not known, but the basin itself was almost as extensive as that of the Copley Greenstone had been.

Andesitic pyroclastic rocks that comprise the lower part of the Mississippian Baird Formation were deposited after a minor episode of uplift, erosion, and renewed local subsidence that had followed Bragdon sedimentation. Volcanism diminished and then was renewed, but during the intervening period of quiescence, fossiliferous mudstone and limestone were deposited in a shallow sea. The extent of the basin that received products of Baird volcanism and sedimentation is not known; Baird rocks are exposed in a narrow belt along or west of the McCloud River that extends northward from the Pit River junction almost to the county line. The rocks dip eastward, but are not exposed farther to the east, so that the extent of the basin in this direction is unknown.

The Pennsylvanian Period is regarded as a time during which deposition did not occur, probably because the area had been regionally uplifted, but it may be that part of the Baird itself was laid down during Pennsylvanian time (Coogan, 1960, p. 250).

Early in the Permian Period the area once again sank below advancing seas, and the McCloud Limestone was deposited; it contains fossils that suggest deposition in a shallow, warm sea at some distance from shore.

There followed two full cycles of uplift, submergence, and sedimentation dominated by volcanism. The first cycle included northward tilting and partial erosion of the McCloud Limestone, and accumulation of tuffaceous sediments, mafic lavas, and mafic pyroclastic debris of the Nosoni Formation. The second cycle concluded with deposition of the andesitic pyroclastic rocks and flows of the Dekkas Formation. Probably Dekkas volcanism continued uninterrupted into Triassic time, when erupted material became dacitic instead of andesitic, forming the Bully Hill Rhyolite. Much of the Dekkas and Bully Hill flows and pyroclastic debris were emplaced in water. The principal areas of volcanism and deposition for both units were not the same, however, for Dekkas rocks now are exposed in a wide belt the trend of which is more or less coincident with that of the McCloud River, whereas Bully Hill rocks crop out chiefly from Bully Hill southeastward to Lawrence Basin near Whitmore.

As the intensity of Bully Hill volcanism decreased, the region slowly subsided and fine-grained sediments (Pit Formation) were deposited, at first locally in restricted basins and then over almost all of the previously active volcanos. Volcanism continued in its dying phases during deposition of the Pit Formation.

The shallow basin into which Pit sediments were deposited persisted throughout Middle and Late Triassic time. The Hosselkus Limestone was laid down conformably on the Pit sediments, succeeded by thinly bedded sediments of the Brock Shale.

An interval of intense volcanism followed in Late Triassic time, and several hundred feet of tuff, breccia, flows, and related sediments were laid down. Volcanic activity fell off rapidly, and the remainder of the Triassic was marked by sedimentation in deeper seas interspersed with sporadic volcanism. These volcanic and sedimentary rocks comprise the Modin Formation.

Basins in which volcanic and sedimentary rocks accumulated had become, in general, progressively more restricted since the Late Paleozoic. The Baird, Dekkas, and Nosoni Formations (Mississippian to Permian) crop out in relatively narrow, north-trending belts near the McCloud River; they dip eastward and presumably underlie much of the area to the east where only younger rocks are now exposed. Triassic rocks were laid down in basins, the western margins of which were situated farther east during each succeeding interval of sedimentation. Jurassic rocks are exposed only in the area around Big Bend and Potem Creek, but may have been deposited to the east in the region now covered by Tertiary volcanic rocks; the basin margins appear to have moved progressively southward as well as eastward beginning in Early Jurassic time, so that Middle Jurassic rocks now are exposed over only a few square miles.

The advent of Jurassic time was marked by uplift and erosion, followed by subsidence that permitted the advance of shallow seas. Volcanism began once again, and thick, local deposits (Arvison Formation) of volcanic breccia, conglomerate, tuff, and intermediate to mafic flows accumulated. As volcanic activity subsided, fine-grained sediments of the Middle Jurassic Potem Formation were deposited; local volcanism continued during Potem time, and the resulting breccia, tuff, and andesitic flows (Bagley Andesite) are underlain by the earliest Potem rocks and locally interfinger with them.

Finally volcanism and sedimentation ceased, and there followed a major epoch of deformation and igneous intrusion (Nevadan orogeny) during which the present structural framework of the Klamath Mountains was established. Deformation prior to this time had consisted of recurrent uplift and tilting, as related in the paragraphs above. The Nevadan orogeny was preceded by the injection of small dikes of diabase into Paleozoic rocks of the West Shasta district; some cut rocks of Mississippian age and almost all bear evidence of alteration that probably occurred during regional metamorphism associated with the orogeny.

The epoch of orogeny opened with the initiation of regional compressive forces acting from the east and west, or perhaps from the southeast and northwest. The eastward tilt of most of the rocks along and east of the McCloud River dates from this event, as do the broad, gentle, north- to northeast-trending folds such as the anticlines of Iron and O'Brien Mountains. Smaller, subsidiary, similarly trending folds were formed at the same time. Probably the broadly arcuate trend of rock formations west of Redding in Shasta and Trinity Counties (part of the "Klamath arc") originated from this first phase of regional deformation. The reason that the trend is arcuate rather than linear is not known, but the trend certainly suggests that the regional forces were quite complex.

Following the epoch of orogeny, broad forces acting as a shear couple in a generally north-south direction superimposed a series of northwest-trending folds on the already folded strata. It was probably during this time that the three major fault zones postulated to exist in Shasta County were formed. A left-lateral fault that formed just east of the McCloud Limestone served to control the subsequent emplacement of the mafic quartz diorite dike that now surrounds most of the McCloud (and has destroyed almost all direct evidence of the fault's existence). This faulting probably also was responsible for the disruption of the McCloud into discrete blocks and for the rotation of these individual blocks to their present, northwest-striking position. A widespread thrust fault, which might also have been formed at this time, is thought to separate the Bragdon Formation and Copley Greenstone throughout the French Gulch district. Finally, a major thrust zone might have controlled the emplacement of the sub-horizontal mafic sheet that crops out in northwestern Shasta County and the Trinity Alps and separates the central metamorphic belt from the eastern Paleozoic and Triassic belt. If such is the case, then the thrust most probably was formed

during this phase of the orogeny. Many other major faults of a much more limited scope, and swarms of insignificant fractures, formed in response to the regional shearing; their movements tended to be relatively small.

The general concept of east-west compression followed by north-south shearing is supported by the recent observations of many workers in the Sierra Nevada, who have concluded from analyses of rock fabrics in widely scattered areas that the same sequence of events took place during the Nevadan orogeny.

As regional forces of deformation waned, the granitic masses of the Mule Mountain and Pit River stocks were emplaced. Both bodies are only slightly deformed, suggesting that they had become largely crystalline at the same time that orogenic forces were only weakly active. Another line of evidence is presented by the fact that the Mule Mountain magma had metamorphosed adjacent rocks of the Copley Greenstone, changing them to amphibolite. If strong regional metamorphism had occurred afterward, these rocks would have been retrogressively metamorphosed to chlorite-albite schist; but inasmuch as this has not happened, the intrusion must have occurred after the main pulse of regional deformation.

Emplacement of the mafic quartz diorite along the fault adjacent to the McCloud Limestone was accomplished following solidification of the Pit River stock, inasmuch as fine-grained dikes of the quartz diorite cut the stock. Probably at about this same time, the widespread ultramafic sheet was emplaced from the east, eventually underlying an area of about a thousand square miles. It may have followed intrusion of the Mule Mountain stock and preceded the Shasta Bally batholith, inasmuch as only the latter contains inclusions of ultramafic material. On the other hand, the sheet has been folded and locally metamorphosed in the Trinity Alps; if no substantial orogeny followed emplacement of the Mule Mountain stock, a seeming impasse is encountered. It is possible that orogenic activity of a somewhat restricted nature occurred in the Trinity Alps after similar activity in southwestern Shasta County had ceased.

An uncertain position in this chronology is occupied by the numerous northwest-trending dikes of quartz diorite, dacite porphyry, granodiorite, and aplite that crop out in the region west of the McCloud Limestone and northeast of the Shasta Bally batholith. In all likelihood they are related to the batholith and were injected at about the same time, but there is no direct evidence of this. Dikes of "birdseye" porphyry and aplite, and veins of quartz, intrude the Mule Mountain stock and hence postdate it; the "birdseye" porphyry in turn is cut by lamprophyre dikes that themselves seem to be related to the Shasta Bally batholith. All these lesser dikes are undeformed and thus were injected after the regional stresses had ceased.

Emplacement of the Shasta Bally batholith was the next event. Curtis *et al.* (1958, p. 5) determined by the potassium-argon method that magma of the batholith solidified 134 million years ago; this fixes the age of the batholith at approximately that of the boundary between the Jurassic and Cretaceous periods.

Hydrothermal activity throughout much of the Klamath Mountains in Shasta County accompanied and followed emplacement of the Shasta Bally batholith. Introduction of soda, silica, and other constituents resulted in widespread albitization, silification, and chloritization of the metamorphosed rocks and of the Mule Mountain stock. Normal faulting took place during this time, thus providing feeder channels for the ore solutions that were the culminating phase of the hydrothermal activity; faults continued to form, however, after ore deposition had ceased, and some of them offset the newly-formed ore bodies.

The studies of Curtis *et al.* (1958, p. 11–12) have shown that the Shasta Bally batholith slowly rose toward the surface at the same time that fine-grained, relatively undisturbed sediments of the Knoxville Formation were being deposited about 25 miles to the south. There is no evidence in the Upper Jurassic and Lower Cretaceous sediments of the area that the adjacent land mass to the north was being rapidly uplifted during their deposition. Indeed, the progressively northeastward movement of the western margins of the marine basins of deposition during Knoxville and Early Cretaceous time show that the area south of the presently exposed batholith actually was actively subsiding.

Sedimentation continued here through Early and into early Late Cretaceous time but did not occur several miles to the east; during the middle and later part of the Late Cretaceous, however, sediments were also being deposited north of the present site of Redding and all along the present site of the eastern foothills of the Great Valley, as far east as the region between Round Mountain and Shingletown. Isolated exposures of massive sandstone along the eastern rim of the Pit River Canyon between Hillcrest and Big Bend also may represent sedimentation during this time. There followed an interval of uplift, withdrawal of the seas, and extensive erosion.

No sediments of Paleocene age are known in Shasta County, but continental deposits of clay, sand, and gravel (Montgomery Creek Formation) were laid down in a deltaic environment during the Eocene Epoch; they are restricted to a zone 10 miles wide between upper Kosk Creek and the vicinity of Shingletown. Another long interval of erosion followed, and deposition of sedimentary rocks is not recorded until the late Pliocene.

Volcanism marking the earliest beginnings of the Cascade Range probably began during the Oligocene Epoch. Although no record of this activity exists in Shasta County, volcanic material in beds of tuff and tuffaceous sandstone in the continental Weaverville Formation of Trinity County is thought to have come from eastern sources; whether these sources were in Siskiyou, Shasta, or one of the other northeastern counties is, however, not known. Intensely altered volcanic rocks exposed at Battle Creek Meadows in northeastern Tehama County underlie pyroclastic rocks correlative with the upper Pliocene Tuscan Formation; whether they were extruded during the middle or early part of the Pliocene, or even during the Miocene time, also is not known.

Continental sand, gravel, and clay of the Tehama Formation poured into the ancestral Great Valley from the north and west during the late Pliocene, at the same time that mudflows, lava flows, tuff, and volcanic sedimentary rocks (Tuscan Formation) came from the east. The age assigned to the Tehama Formation is derived from a fossil fauna found near its base; potassium-argon dating of a welded tuff in the Tuscan at Bear Creek Falls shows that it is 3.3 million years old, and therefore also late Pliocene in age. The Klamath Mountains, meanwhile, had been eroded to a condition of low to moderate relief; portions of this eastward-dipping erosion surface ("old Klamath surface") are still preserved, at elevations ranging from 4,000 to 7,000 feet.

At the same time that the Great Valley was receiving the products of sedimentation and volcanism, other sediments were accumulating in lakes in basins of interior drainage, such as that at the junction of the Pit River and Hat Creek.

After the Tuscan and Tehama Formations had been laid down, the entire region was subjected to deformation. The Klamath Mountains were uplifted and the Tehama Formation gently warped. Gentle folds such as the Chico monocline and Jellys Bend anticline, as well as the more abrupt monocline forming the south rim of the Shingletown plateau, were formed at the same time. Extensive fracturing in the Tuscan Formation close to the Chico monocline and in the area between Shingletown and the headwaters of Clover Creek also dates from this event.

Volcanism interspersed with faulting continued in the Cascade Range through the Pleistocene, covering most of the eastern half of Shasta County and building up the chain of high peaks trending northward from Lassen Peak. A thin veneer of continental gravels (Red Bluff Formation) was deposited over much of the Great Valley, while terrace gravels were being laid down locally in the Klamath Mountains. Erosional and depositional terraces formed along major streams in the Great Valley following the Red Bluff sedimentation. Uplift continued in the whole region into Late Pleistocene or Holocene time, as evidenced by the steep, narrow "inner gorges" of such streams as Mill and Bear Creeks in the Cascade Range province and the Pit and Sacramento Rivers in the Klamath Mountains province. Glaciation of uncertain age, but probably Pleistocene, mantled portions of the Klamath and Cascade provinces with debris, in Shasta County notably at Magee Peak and northwest of Mt. Diller. Volcanic flows, the most extensive of which filled Hat Creek Valley, were extruded during the Holocene, and Lassen Volcanic National Park was recently the scene of sporadic volcanism.

Geology of the Geomorphic Provinces

KLAMATH MOUNTAINS

In Shasta County this province includes an irregular area embracing the western portion of the county.

The geology and geological history of the Klamath Mountains are the most complex of the five geological provinces in the county and even yet are imperfectly understood. W. P. Irwin (1960) has divided the Klamath Mountains into four major belts, three of which are present in Shasta County; from southwest to northeast these are, with minor modification, designated here the western Paleozoic belt, central metamorphic belt, and eastern Paleozoic and Triassic belt. In addition, intermittently exposed Jurassic rocks occur in a relatively narrow, north-trending zone between Lawrence Basin and Big Bend. These subdivisions of the province are discussed below in this order.

Western Paleozoic Belt

Rocks of this belt occupy the southwesternmost tip of the county; they are bounded on the east by sedimentary rocks of the Coast Range and Great Valley provinces and to the northeast by a postulated northwest-trending fault that passes along part of the Middle Fork of Cottonwood Creek and Ditch Fork of Duncan Creek. Irwin (1960, p. 63) says of this fault: "(It) . . . is along the west side of the central metamorphic belt, and extends from the Jurassic and Cretaceous overlap southwest of Redding northwestward to the Salmon River. Along much of its length the foliation of the strata on either side dips moderately to steeply northeastward, and the boundary seems likely to be a reverse fault whose attitude is nearly parallel to the foliation".

The principal rock types present in the western Paleozoic belt are thinly bedded dark chert, mica schist, quartzite, phyllitic slate, and metaconglomerate. N.E.A. Hinds named them the Chanchelulla Formation in an abstract in 1931; subsequently he presented a description of them (1932, p. 392). They have not been studied in detail, and therefore their age and relationship to rocks of the adjacent central metamorphic belt are not clear. Sparse fossils have been found in limestones of the western Paleozoic belt, but none are reported from Shasta County. An ammonite found near Wildwood in Trinity County was identified as Permian (Irwin, 1960, p. 26).

Central Metamorphic Belt

This northwest-trending belt is bounded on the southeast near Ogo Station by Coast Ranges sedimentary rocks and on the southwest by the western Paleozoic belt, just described. Its relationship to the eastern Paleozoic and Triassic belt is obscure, because the two are separated by the granitic mass of the Shasta Bally batholith and, farther north above Trinity Reservoir, by an extensive mass of ultramafic rock.

Most of this belt in Shasta County consists of light to dark gray quartz-mica schist, micaceous quartzite, quartzite, and metaconglomerate of the Abrams Formation. A thin, discontinuous zone of dark green hornblende schist and chlorite schist of the Salmon Formation crops out northeast of North Fork Cottonwood Creek. The mutual relationship of these formations has long been a matter of some controversy. Recently, Davis and Lipman (1962) concluded that metasedimentary rocks previously assigned to the Abrams Formation occur both above and below the Salmon; they proposed that the term "Abrams" be abandoned and that the lower and upper metasedimentary units be

named the Stuart Fork and Grouse Ridge Formations, respectively. The area they studied lies north of Trinity Reservoir, so that the ultimate effect of their stratigraphic revision on the "Abrams" rocks of Shasta County must for the present remain a matter of speculation.

As fossils have never been found in the Abrams and Salmon Formations, and as their relationship to rocks of adjacent belts remains obscure, their age is unknown. They generally have been considered to be older than the oldest rocks of known age in the region (Copley Greenstone, Devonian(?)), because they are metamorphosed to a much higher degree. However, Irwin (1960, p. 20) pointed out, ". . . the possibility that the Abrams and Salmon formations may be metamorphic facies of adjacent formations of Paleozoic age should not be disregarded", and Davis (1963, p. 333, ff.) concisely summarized the existing state of knowledge: "The Salmon and Grouse Ridge formations in the Minersville and Coffee Creek quadrangles have been affected by two periods of metamorphism: (1) regional metamorphism under conditions of the almandine-amphibolite facies; and (2) retrogressive metamorphism under conditions of the greenschist facies. Since metamorphic event (1) has not been recognized in Copley or post-Copley rocks to the east, a pre-Middle Devonian age for the Salmon and Grouse Ridge formations is indicated; this suggestion is speculative."

Eastern Paleozoic and Triassic Belt

Interbedded metasedimentary and metavolcanic rocks, ranging in age from Middle Devonian to Late Triassic and divided into 13 recognized formations, comprise this belt. The total stratigraphic thickness is about 11,000 feet in the West Shasta copper-zinc district and 20,000 feet in the East Shasta district; approximately 60 percent of the section in both areas is volcanic in origin.

The oldest rocks in the eastern Paleozoic and Triassic belt belong to the Copley Greenstone, a succession of light to dark green, massive and locally schistose amphibolites derived from interlayered volcanic flows, tuffs, agglomerates, and very minor tuffaceous shale. The base of the Copley is not exposed, so that its cited thickness of 3,700 feet (Kinkel *et al.*, 1956, p. 10) must be regarded as a minimum figure. It is exposed principally in the area bounded by lower Clear Creek, Mad Mule Mountain, and O'Brien Mountain. Other scattered exposures are found north of French Gulch, along Dog Creek, west of Lamoine, and just east of the Sacramento River between Gibson and the county line. Except for this latter occurrence and a small area east of Project City, the Copley is not found east of Highway 99. Its age is generally considered to be Middle Devonian.

Conformably overlying the Copley and locally either interfingering with it or exhibiting a transitional relationship is the Balaklala Rhyolite. This series of silicic, soda-rich volcanic flows, plugs, and pyroclastic rocks attains a thickness of 3,500 feet near its principal source areas in the West Shasta copper-zinc district, but thins rapidly toward its margins at O'Brien Mountain and near Buckhorn Summit. Fresh flow rock typically is very hard, siliceous in appearance, and light green or light gray; it is very fine-grained and contains phenocrysts of quartz or feldspar that vary in abundance and size from flow to flow. This latter feature has been used by Kinkel *et al.* (1956), who thus, by mapping major subdivisions of the formation, were able to define the horizon most favorable as a host rock for massive sulfide ore deposits. As in the case of the Copley, the age of the Balaklala Rhyolite is thought to be Middle Devonian.

Above the Balaklala, at some localities resting conformably on it but at other localities gradational with it, is the Kennett Formation, composed chiefly of slightly metamorphosed dark shale, mudstone, and limestone. It usually occurs as scattered erosional remnants capping hills and has a maximum thickness of 400 feet (Kinkel *et al.*, 1956, p. 34). The Kennett occurs west of Shasta Lake, at O'Brien Mountain, and possibly southwest of Redding and near Project City. It is the oldest rock unit in the Klamath Mountains province in Shasta County that has yielded direct evidence of its age; fossils collected near Backbone Creek have been identified as Middle Devonian or early Late Devonian species. The ages of the Copley greenstone and Balaklala Rhyolite, mentioned above, are based on these fossils and the conformable nature of the Copley-Balaklala-Kennett sequence.

A thick sequence of black- to buff-colored, weakly metamorphosed shale, sandstone, and conglomerate of the Bragdon Formation overlies the Kennett. The contact between these two units is poorly exposed but is thought generally to be conformable with perhaps local development of an erosional unconformity. The maximum measured thickness of Bragdon in Shasta County is about 3,500 feet (Kinkel *et al.*, 1956, p. 38), but this measurement applied only to the lower part of the stratigraphic succession, and the total thickness of the Bragdon may well be considerably greater. The Bragdon is the most widely exposed of the Klamath Mountains formations in Shasta County; it is found principally north of a line drawn between Buckhorn Summit and the Pit River bridge, and west of the McCloud River. In the northern part of the county, from opposite Gibson to the county line, the area of exposed Bragdon thins considerably so that it is only a few miles in width. In spite of such an unusually broad expanse of exposed rock, few fossil localities have been found. Collections made by J. S. Diller (1906, p. 3) from north of Lamoine and near Nawtawaket Mountain were identified as "early Carboniferous", i.e. Mississippian; this age is confirmed by the stratigraphic position of the Bragdon between the fossil-bearing Kennett (Middle Devonian) and Baird (probably Mississippian, possibly Pennsylvanian) Formations.

The Baird Formation crops out in a long, narrow, east-dipping zone along both sides of the McCloud River arm of Shasta Lake as far as the McCloud River bridge; north of there it is exposed from High to Tombstone Mountains and along Squaw Valley Creek. The lower part of the Baird consists principally of metamorphosed volcanic flows and pyroclastic rocks;

the middle portion is dominantly dark gray, siliceous mudstone and minor limestone; and the upper part consists of greenstones that generally are dark greenish gray, massive, and quartz bearing. The age of the Baird is generally accepted as Mississipian, but Coogan (1960, p. 350) notes that ". . . the presence of *Staffella?* In the beds a few feet below the Baird-McCloud contact at this locality [McCloud River bridge] indicates that here the topmost beds of the Baird formation are at least Pennsylvanian and maybe Permian in age".

The massive, cliff-forming McCloud Limestone of Permian age is exposed between the Baird to the west and the Nosoni and Dekkas Formations to the east; as a rule, however, it is separated from these units by a long, narrow dike of mafic quartz diorite that probably was emplaced along a prominent fault or fault system. It consists of fine-grained, light gray limestone that locally contains noteworthy amounts of chert and dolomite patches and zones. At and near contacts with the mafic quartz diorite dike, the limestone is coarsely crystalline and irregular masses of tactite have been developed. Abundant fossils in the McCloud, mostly corals, crinoids, brachiopods, and fusulinids, have served to establish its age beyond question.

Overlying the McCloud and exposed east of it in a zone a few miles wide are rocks of the Nosoni and Dekkas Formations. Albers and Robertson (1961, p. 24) believe that an erosional disconformity separates the McCloud and Nosoni in the East Shasta copper-zinc district, but farther north Coogan (1960, p. 251) found that the Nosoni overlies the McCloud conformably, with 15 feet of interbedded greenish tuff, black chert, and gray limestone marking the contact. The Nosoni Formation consists chiefly of bedded pyroclastic rocks in the lower part and black shale and slate in the upper part. The overlying Dekkas Formation is composed principally of massive green tuff breccia and thin flows and tuffaceous beds, somewhat similar in appearance to those of the Nosoni. The black shale of the Nosoni is not everywhere present, however, so that it is not always possible to locate the top of the formation; to overcome this difficulty, Coogan has proposed use of the term Bollibokka Group ". . . because it designates a mappable lithologic unit and because the rocks are not readily subdivided into two formations everywhere they crop out" (1960, p. 243, 250). The Bollibokka Group is about 10,000 feet thick at its type section along Nosoni Creek. Both the Nosoni and the lower part of the Dekkas have yielded collections of poorly preserved fossils indicative of late Permian age. The upper part of the Dekkas has not yielded any fossils but is conformably overlain by the Triassic Bully Hill Rhyolite and Pit Formation; hence, the Dekkas may represent volcanic activity that began in Late Permian time and continued into the Triassic.

The Bully Hill Rhyolite overlies the Dekkas, is overlain in turn by the Pit Formation, and locally is interbedded with both units. Its principal exposures are at Bully Hill and in the vicinity of Ingot. Acidic lava flows and pyroclastic rocks comprise the bulk of the Bully Hill Rhyolite, together with subordinate intrusive rock, shaly tuff, and mafic flows and pyroclastic rock. Much of the acidic rock contains phenocrysts of quartz and plagioclase, but some of it is fine grained and non-porphyritic. The Bully Hill Rhyolite probably represents a group of interfingering and overlapping extrusive volcanic rocks that emanated from several eruptive centers. Because of its position between units of known age, the Bully Hill is considered to be Triassic.

Lying east of the Bully Hill and Nosoni-Dekkas Formations is a broad belt of Middle and Upper Triassic rocks that are largely sedimentary in origin. Bear Mountain, Sage Hen Hill, Brock Mountain, and Hawkins Creek are all underlain by these rocks. In order of decreasing age, they have been divided into the Pit Formation, Hosselkus Limestone, Brock Shale, and Modin Formation.

About two-thirds of the Middle Triassic Pit Formation is composed of shale, mudstone, and siltsone, and the remainder is chiefly tuff and tuff breccia. The relative abundance of volcanic rocks at localities in the Pit suggests that Pit sediments were deposited in a shallow sea surrounding a few isolated volcanoes.

Conformably overlying the Pit Formation is the Hosselkus Limestone of Late Triassic age, which attains a thickness of about 400 feet. The lower part is hard, relatively pure limestone, but the middle and upper portions are conspicuously siliceous. It is exposed principally at Devils Rock and Gray Rocks north of Brock Mountain; other exposures occur along the North Fork of Squaw Creek. Albers and Robertson (1961, p. 37) included the prominent limestone outcrops along Highway 299 near Ingot in the Pit Formation, although previous workers had regarded them as part of the Hosselkus; their decision was based on the observations that rocks "indistinguishable" from those of the Pit are interbedded with these limestones, and that they contain fossils of Middle rather than Late Triassic age.

About 400 feet of interbedded dark argillite and lighter-colored tuff and tuffaceous sandstone rest on the Hosselkus Limestone or, where it is absent, on the Pit Formation; these sediments, termed the Brock Shale, vary little in thickness and probably occur continuously between the Pit-Hosselkus and Modin exposures.

The Modin Formation, the easternmost formation of the eastern Paleozoic and Triassic belt, is exposed in a crudely arcuate zone two to three miles wide extending from Sage Hen Hill near Ingot, through Brock Butte and Tamarack Mountain, to Grizzly Peak and Devils Mountain. It attains a thickness of 5,500 feet along Kosk Creek and Devils Canyon, where Sanborn (1960, p. 8–11) has divided it into three members (Hawkins Creek, Devils Canyon, and Kosk). The basal Hawkins Creek and uppermost Kosk Members are dominantly volcanic in character, consisting of tuff, agglomerate, flows, and volcanic sandstone and conglomerate. The middle Devils Canyon Member is composed of limestone lenses, tuffaceous limestone, and fine-grained sandstone.

Jurassic Rocks of Eastern Shasta County

These rocks underlie a relatively small portion of the county. They are divided into three formations, the lowermost of which unconformably overlies the Upper Triassic rocks just described. These rocks are the youngest of the "basement" rocks in Shasta County, and are designated the Arvison Formation, Bagley Andesite, and Potem Formation.

The Lower Jurassic Arvison Formation was defined by Sanborn (1960, p. 11) as ". . . that series of dominantly pyroclastic beds with minor andesitic flows, which are intermediate between the Modin and Potem formations and which do not appear to be continuous with the Bagley andesite of Diller". Most of the Arvison consists of agglomerate, volcanic breccia, and conglomerate, but minor amounts of tuff, sandstone, and basic volcanic flows also are present; it attains a thickness of 5,090 feet at its type section. Its contact with the overlying Potem Formation is unexposed in the Big Bend area, but the nature of weathered debris and talus at the contact led Sanborn (1960, p. 13) to believe that it is gradational.

The Potem Formation of Early and Middle Jurassic age consists principally of argillite and fine-grained tuffaceous sandstone with small amounts of conglomerate, tuff, limestone, and coarse pyroclastic material. J. S. Diller (1906) had considered the Bagley Andesite to be older than the Potem, but Sanborn (1960) traced it from its type area into the Big Bend region and found that it overlies and interfingers with the basal beds of the Potem; he thus regarded it as merely a volcanic facies of the Potem Formation. Unconformably overlying the Potem and Bagley Andesite are gravels of the Eocene Montgomery Creek Formation, described in the section on the Great Valley province, and late Tertiary volcanic rocks, described in the section on the Cascade Range.

Intrusive Rocks of the Klamath Mountains

The principal exposure of granitic rock in Shasta County is that of the Shasta Bally batholith, a large mass of generally unaltered, biotite-hornblende quartz diorite that trends northwestward from Igo and Ono to the county line and beyond. There is no evidence that this impressive volume of rock represents more than a single episode of intrusion, although its composition ranges locally from gabbro to granodiorite. Its contacts with adjacent rocks are sharp; along its northeast flank it is bounded by amphibolite and gneissic rocks derived from the Copley Greenstone, Balaklala Rhyolite, and Bragdon Formation, whereas to the southwest it is bordered by a narrow breccia zone of indeterminate parentage. Several small satellites, correlated on the basis of similar lithology, crop out east of the batholith, and one of these penetrates the nearby Mule Mountain stock. Curtis *et al.* (1958, p. 5) have found that the Shasta Bally batholith is about 134 million years old (latest Jurassic).

The Mule Mountain stock crops out from the vicinity of Mule Mountain northward to the settlement of Minnesota and, in contrast to the Shasta Bally batholith, is profoundly altered locally by late magmatic solutions. Most of the rock is a trondhjemite, consisting of sodic plagioclase, quartz, epidote, and chlorite. Altered phases of it, which are conspicuously lighter colored than the unaltered portions, have been modified by addition of silica and soda to form an albite granite; clusters of epidote and of quartz have the appearance of single-crystal phenocrysts. The Mule Mountain stock is characterized by numerous quartz veins two inches to several feet thick, and by less abundant dikes of aplite.

Other large granitic bodies in Shasta County are the Pit River stock near the Pit River bridge on Highway 99 (Albers and Robertson, 1961, p. 38–41), and the granodiorite of Castle Crags (Averill, 1931a, p. 20–21). The Pit River stock consists of granodiorite and albite granite with minor inclusions of hornblende quartz diorite and is lithologically similar to the Mule Mountain stock. The intrusive mass of Castle Crags has not been studied in detail, but Averill (1931a, p. 21) notes the presence of several "different varieties of crystallization"; abundant quartz and plagioclase, phenocrysts of pink potassium feldspar, and subordinate biotite, hornblende, and magnetite are the principal mineral constituents in much of the rock.

Several other granitic intrusive rocks, comparatively minor in extent, occur in Shasta County. They range in composition from gabbro to granite and in size from small veinlets to the 25-mile length of dike that has invaded the McCloud Limestone.

Of these rocks, the economically most important are the "birdseye porphyry" dikes of the French Gulch area and the augite-quartz diorite dike associated with the McCloud Limestone. "Birdseye porphyry" is a local mining term applied to dioritic or dacitic rock characterized by prominent phenocrysts of plagioclase or quartz set in a sugary-grained groundmass, together with inconspicuous phenocrysts of hornblende or, sparingly, biotite. Dikes of this type occur within about 20 miles of contacts of the Shasta Bally batholith and probably are related to it. "Birdseye porphyry" dikes are associated with gold mineralization near French Gulch, at Mad Mule Mountain, and in other parts of the county west of the McCloud and Sacramento Rivers.

The elongate mass of augite-quartz diorite that intrudes the McCloud Limestone along at least 25 miles of its length is of interest because of the contact-metamorphic mineralization associated with it. Further, its position may have been controlled by a pre-existing system of faults, the magnitude of which suggests a major structural feature of the Klamath Mountains. Most of the dike is composed of dark, fine-grained, massive rock containing chiefly plagioclase, quartz, and augite. Locally the grain size coarsens somewhat, as at the Shasta Iron mine.

Ultramafic intrusive rocks crop out in Shasta County in three widely separated areas: south of Deadhorse Ridge in the southwestern tip of the county, along the southwestern margin of Shasta Bally batholith, and west of the Sacramento River from Lamoine north to the county line. The last two exposures are considered by Irwin and Lipman (1962, p. 18) to be "parts of a great, once-continuous subhorizontal sheet that separated the rocks of the central metamorphic belt from

the structurally overlying rocks of the eastern Paleozoic belt". Little detailed work has been done on the ultramafic rocks. They are mostly peridotite, with dunite and pyroxenite being important locally, and usually are partly serpentinized. Olivine, augite, and minerals of the serpentine and spinel groups are the principal minerals reported. Dunite southwest and east of the granodiorite of Castle Crags contains unusual olivine crystals that exhibit perfect cleavage faces several millimeters long (Hawkes, 1946).

Mineral Deposits of Klamath Mountains Province

Eleven metallic and seven nonmetallic commodities occur in the Klamath Mountains of Shasta County in quantities sufficient to have warranted mining, quarrying, or dredging. They include chromite, copper, gold, iron, manganese, molybdenite, platinum, pyrite, silver, tungsten, zinc, asbestos, barite, limestone, sand and gravel, dimension and crushed stone, and talc. Cadmium and lead have been produced as byproducts, and quicksilver and graphite have been sought by prospecting. Mineral springs were once used for bathing and as a source of bottled water.

GREAT VALLEY

This province is here defined to include the Cretaceous and Tertiary sedimentary rocks exposed several miles east of Redding and Anderson and partly covered by the Tertiary and Quaternary volcanic rocks of the Cascade Range province (see Plate 1). The eastern province border is drawn so that the area in which outcrops are dominantly sedimentary is included in the Great Valley. Admittedly, this arbitrarily includes some rocks of the Cascade Range in the Great Valley province. The alternatives, however, are either to include significant outcrops of marine sedimentary rocks in the Cascade Range province or to create a minor "mixed" subprovince. The authors feel that the course of action taken is satisfactory for a general understanding of the geology of the county.

Rocks in the western part of the Great Valley province are Early and Late Cretaceous in age and consist dominantly of marine sandstone, shale, and conglomerate. To the north and west they lap unconformably on older crystalline rocks of the Klamath Mountains; to the east they are covered by late Tertiary and Quaternary sediments of the Sacramento Valley. Sand, gravel, and alluvium occupy many canyon and stream bottoms.

The stratigraphic nomenclature of the Cretaceous rocks was not well defined until the work of F. M. Anderson (1933). He called the Lower Cretaceous rocks "Shasta Series," which he divided into the older Paskenta beds and younger Horsetown beds. Rocks of latest Early Cretaceous and Late Cretaceous age were assigned to the Chico Formation.

In 1956, M. A. Murphy published a revised nomenclature based on studies in the Ono area. A transgressive basal unit was called the Rector Formation; overlying it is the Ono Formation (approximately equivalent in time to the Horsetown beds), which included two conglomeratic units, the Huling and Roaring River Tongues. Overlying the Ono Formation is a conglomerate, sandstone, and mudstone unit which Murphy and Rodda (1960) later named the Bald Hills Formation, and above this is an unnamed unit of Late Cretaceous age. The Chico Formation was considered not to be present in this area.

A few years later, Murphy, Peterson, and Rodda (1964) again revised the nomenclature. They included all the Cretaceous rocks in the Ono and Clear Creek areas in a unit named the Budden Canyon Formation, which was subdivided into the following members, from oldest to youngest: Rector Conglomerate, Ogo, Roaring River, Chickabally, Huling, Bald Hills, and Gas Point Members.

Mineral resources of this region are limited to sand and gravel, building stone, placer gold, and platinum; in portions of the Sacramento Valley close to Shasta County, rocks similar to these have been prospected for natural gas and petroleum, but no production has yet developed.

The oldest rocks in the eastern part of the Great Valley province are marine shale, sandstone, and conglomerate of Late Cretaceous age assigned to the Chico Formation. Popenoe (1943) studied exposures of these rocks north of Redding and Bella Vista and east of Millville. He divided them into six members designated in order of decreasing age, I through VI. Fossils found in member IV indicate that it and possibly member V are equivalent to the lowermost sediments of the Chico Formation at the type section along Chico Creek in Butte County.

According to a chart published by Popenoe *et al.* (1960), sediments of members IV, V, and VI in the Redding-Millville area are equivalent to P. P. Goudkoff's G-1 and lowermost F-2 foraminferal zones in the Sacramento Valley subsurface. Portions of the Upper Cretaceous sediments of the east side of the Valley thus approximately correspond in age to gas-yielding formations in the Willows-Beehive Bend, Arbuckle, Bounde Creek, and possibly other gas fields of the central Sacramento Valley. Prospecting for natural gas in these rocks near Buckeye, Millville, and Anderson has thus far failed to reveal a producing zone. The easternmost exposures of Cretaceous rock are near Big Bend, Whitmore, and Inwood. Massive, locally fossiliferous sandstone at the last locality is thought by Popenoe (1943, p. 311) to be equivalent to his member V.

Continental sediments of the Eocene Montgomery Creek Formation are intermittently exposed in a zone a few miles wide extending from the headwaters of Kosk Creek to the Shingletown area. They rest unconformably on crystalline basement rock or on Cretaceous sediments. The Montgomery Creek Formation consists of loosely consolidated, light-colored, micaceous sandstone in the southern exposures, whereas the northern part is comprised of moderately consolidated, dark gray-green to yellowish brown conglomerate and coarse sandstone, buff-colored arkosic sandstone, and shale. These sediments were deposited in a deltaic and locally lacustrine environment by streams flowing from the east or northeast.

Coal has been found in the Montgomery Creek Formation at the head of Kosk Creek and between Clover and Montgomery Creeks. It occurs as lignitic

or sub-bituminous seams one to six feet thick, and has been prospected and exploited in a small way.

Fluviatile sediments of the Tehama Formation are exposed chiefly west of the Sacramento River. They dip gently eastward and, although they crop out in a belt 12 to 10 miles wide in Tehama County, they are almost entirely covered by later sediments in Shasta County. The principal areas of exposure are north of Cottonwood Creek and east of Gas Point and along the bluffs forming the south bank of Clear Creek; scattered exposures are visible in roadcuts north of Redding.

The Tehama Formation consists chiefly of massive, uncemented, poorly sorted silt with conglomeratic lenses and clayey interbeds derived from tuffaceous material. Foreset bedding and the composition of pebbles in the unit show that it was derived from erosion of rocks in the Coast Ranges to the west and the Klamath Mountains to the north and northwest. The sediments dip gently toward the axis of the valley, and grade into a unit of mixed origins to which Anderson and Russell (1939, p. 234) applied the term "Tuscan-Tehama sediments". These consist of pebbles and sand derived from the basement complex of the Klamath Mountains to the north, intimately mixed with volcanic pebbles, sand, and ashy silt and clay derived from eastern sources. "Tuscan-Tehama sediments" underlie mudflow debris of the Tuscan Formation (see section on Cascade Range province) near and east of Bella Vista and Palo Cedo. The Tehama and Tuscan Formations generally are thought to interfinger in the subsurface along the axial zone of the Valley. It is probable that the "Tuscan-Tehama sediments" are the east-side equivalent of the upper part of the Tehama Formation, and that they too interfinger with the Tehama.

These units are very important to the economy of the Sacramento Valley in Shasta County, because they are the source of most of the ground water on which settlements outside the incorporated areas must rely. In addition, the Tehama Formation has yielded economic quantities of natural gas in the Corning area (Tehama County), although no commercial discoveries have been made as yet in Shasta County.

At or near the base of the Tehama Formation is a distinct, light-gray to pink, dacitic tuff unit designated the Nomlaki Tuff Member of the Tehama Formation. It crops out at Gas Point and near Redding Bar on Clear Creek and has been encountered in water wells in Oregon Gulch. It is massive, poorly consolidated, and ranges from 20 to 60 feet in thickness. Its source is generally thought to lie east of the Sacramento Valley. Anderson and Russell (1939, p. 245) regard a welded tuff exposed near Inwood as being near-source material of the Nomlaki. P. A. Lydon has studied in detail the relationships involved, and concludes that the two tuffs are not segments of the same ash flow. It is more likely that the source of the Nomlaki Tuff is genetically related to the intrusive plugs of Tuscan Buttes. The welded tuff east of Redding is described in the section on the Cascade Range province.

The Nomlaki Tuff has been used locally in Shasta County as building stone and has been investigated by at least one company as an additive for pozzolanic cement. The tuff may also have some potential for use in lightweight building block.

The most widely exposed unit in the Great Valley province in Shasta County is the well-consolidated, flat-lying Red Bluff Formation of Pleistocene age. Boulders, cobbles, and pebbles of the same lithological types as are found in the Tehama Formation are enclosed by a matrix of sandy clay that commonly is deep reddish brown. In western Tehama County the Red Bluff Formation locally is separated from the underlying Tehama Formation by a small angular unconformity, but near the center of the valley both formations are flat lying. Local variations in particle size, matrix composition, and color in the two formations at times render quite difficult the task of distinguishing them in the absence of a structural discordance; as a general rule, however, they can be identified with reasonable certainty.

East of Cow Creek and the Sacramento River, erosion of the dominantly volcanic terrane has yielded a thin but widespread, westward-dipping unit composed of coarse volcanic gravel in an iron-stained, clay matrix. It is especially well exposed east of Millville on the road to Whitmore and along the road east of Balls Ferry Bridge. East of the town of Red Bluff, along State Highway 36, road cuts show volcanic gravel grading upward into typical Red Bluff gravel. The volcanic gravel generally is considered part of the Red Bluff Formation, although its lithology is quite distinct.

Surface exposures of Red Bluff Formation are characterized by poor drainage and development of only a thin soil cover, and it is not uncommon to find extensive areas of soil mounds in it. Locally the Red Bluff has been hydraulicked, drifted, or worked by other methods between Keswick and Ono for its gold content, but specific data on gold content and recovery are lacking. Locally, too, it has been used as a source of clay and of aggregate for concrete, road base, or other applications in construction.

Quaternary terraces occupy benches cut in Red Bluff or Tehama gravels. Some of these consist entirely of reworked Red Bluff material, and, except for their elevation and slight but not consistent differences in matrix material, they are indistinguishable from it. The largest terraces in Shasta County are southwest of Millville and along Cottonwood Creek east of Gas Point. Other small terraces or "bench gravels", such as are found locally along Clear Creek (hydraulicked near French Gulch) and Whiskey Creek, may be upland equivalents of the Red Bluff.

Channels of major streams of the present-day drainage have been cut several tens of feet below the Red Bluff surface and are filled with unconsolidated gravel, sand, and flood-plain alluvium. These deposits have been dredged for gold near Redding and along Cottonwood and lower Clear Creeks and are the source of most of the commercial sand and gravel production in the county.

CASCADE RANGE AND MODOC PLATEAU

Almost half of Shasta County is underlain by the extensive accumulation of volcanic flows, pyroclastic rocks, and associated plugs and minor sedimentary rocks that together comprise the Cascade Range province. The northeasternmost part of the county probably belongs to the Modoc Plateau province. Because its border with the Cascade Range province in Shasta County is ill-defined both topographically and geologically, geologists do not agree on its exact location in this area. Consequently, the two provinces are combined here and in plate 1. Prominent peaks of the Cascade Range include Lassen, Prospect, West Prospect, Fredonyer, and Magee Peaks, and Burney, Chalk, and Bald Mountains. Rocks of this province underlie all of southeastern Shasta County and lap onto and partially cover sedimentary rocks of the Great Valley province and crystalline basement rocks of the Klamath Mountains province.

The most widespread and continuous unit of this province in Shasta County is the Tuscan Formation. Including material in Tehama and Butte Counties, the Tuscan comprises about 330 cubic miles of volcanic debris. Andesitic, dacitic, and basaltic volcanic breccia, tuff breccia, and interlayered flows, sand, gravel, and tuff are the principal rock types. In Shasta County the Tuscan Formation crops out from the Big Bend area south to the county line. To the west, it passes beneath later sediments of the Great Valley and interfingers at least in part with the upper Pliocene Tehama Formation.

A gray, welded tuff member of the Tuscan is exposed northeast and east of Redding, especially between Millville and Chalk Mountain near Inwood; potassium-argon dating of the tuff shows it to be 3.3 million years old, and hence of late Pliocene age. This rock, which has been studied in detail by P. A. Lydon, probably originated as an ash flow emanating from near Lookout Mountain, east of Whitmore. It flowed southwestward for several miles, then turned northwestward near Inwood and moved downslope about 20 additional miles. The outcrop farthest from the source area is an isolated remnant situated near the headwaters of Stillwater Creek. It is unlikely that this tuff and the Nomlaki Tuff are the same, in spite of the apparent similarity of their ages and stratigraphic positions.

Two of the six sources of the Tuscan Formation described by Lydon (1961a) are situated in Shasta County. One is the Lookout Mountain area mentioned above, where interbedded andesitic mudflows and volcanic flows attain a thickness of 1,000 feet. Scattered outcrops of tuff breccia, pumice, and welded tuff near Hatchet Mountain suggest that the Tuscan there might be as much as 600 feet thick and that it, too, is a source area of the Tuscan.

Volcanic rocks older than the Tuscan in the Cascade Range province have been mapped in Tehama and Plumas Counties; their ages are not known with any degree of certainty, but presumably they are not older than Miocene. Tuffaceous rocks of the Oligocene Weaverville Formation in Trinity County contain ash thought to have been derived from great outbursts of volcanism in the Cascade Range during that time, but no direct evidence of this earlier activity remains in the Cascades themselves.

Capping the debris of the Tuscan Formation is a complicated succession of Pliocene basalts and andesites originating from eruptive centers along the higher western flanks of the Cascade Range. During Pleistocene time, volcanism was concentrated along the crest of the range, and massive volcanic piles were built up at Burney Mountain, Magee Peak, and in the Lassen area. Acidic products of volcanism are prominent east of Manton in Shasta and Tehama Counties; a large area is underlain by a loosely consolidated, white pumice tuff between Manton and Forward Mill, north of the county line. Volcanism during Holocene time occurred at scattered locales in the county, prominent among which are Hat Creek Valley, Silver Lake, and Black Butte (near Manton). Volcanism in historic time occurred at Cinder Cone (1850–51) and Lassen Peak (1914–17), and the last addition to the extensive avalanche deposit of Chaos Jumbles originated from steam explosions at the base of the dacite dome of Chaos Crags approximately 270 years ago (Heath, 1959).

Glacial deposits have been mapped on the north slopes of Magee Peak, west of Loomis Peak, and west of Brokeoff Mountain, but glacial material probably is more widespread in the Cascade Range province of Shasta County than present mapping indicates.

Widespread lava flows east of the crest of the Cascade Range are cut by a prominent series of faults trending north-northwest, normal movement along which has formed numerous small basins that subsequently were occupied by younger volcanic flows, lakebeds, or alluvium. Other similar basins were formed by the impounding action of either extensive lava flows ("plains basalts") or flows of limited extent associated with ill-defined flow cones. The two largest basins in northeastern Shasta County are those through which Hat Creek and Fall River flow. Some of the sediments, notably those exposed near the junction of Hat Creek and the Pit River, contain assemblages of diatoms that are of probable late Pliocene age.

Mineral resources of the province include volcanic cinders, diatomite, pumice, pumicite, perlite, sand and gravel, and stone useful for decorative or construction purposes.

Previous Geological Studies

Portions of Shasta County have been studied by a great many geologists during the last hundred years.

Joseph Silas Diller began working in northern California and southwestern Oregon in 1883, and during the succeeding 33 years he published almost 50 articles and maps on the geology and geomorphology of northern California. About half of these concerned areas partly or entirely within Shasta County. His chief contributions were studies of the Redding 30-minute and the Lassen Peak one-degree quadrangles, published as part of the U. S. Geological Survey's Geologic Atlas of the United States (Diller, 1895 and 1906).

Norman E. A. Hinds devoted considerable time between 1928 and 1941 to a study of the Klamath Mountains in Shasta and Trinity Counties. Notable among the 12 of his publications that concern the area were a map of the Redding and Weaverville 30-minute quadrangles and lengthy discussions of the Paleozoic and Mesozoic volcanic rocks of the southern Klamath Mountains (Hinds, 1932, 1933, and 1935).

Studies of the geology and mineral deposits of an area north of Redding, extending from the western county line to the vicinity of Ingot, were made by geologists of the U. S. Geological Survey between 1945 and 1957. Published reports resulting from this work are remarkable for their attention to detail and for the completeness of their descriptions of rock types and structures (Kinkel *et al.*, 1956; Albers and Robertson, 1961; Albers *et al.*, 1964; Albers, 1965). These reports form a scholarly base for any future detailed studies of the Klamath Mountains province in Shasta County.

From 1953 to 1956, reconnaissance geological mapping of approximately 19,000 square miles in northwestern California was done by W. P. Irwin (1960) and other geologists of the U. S. Geological Survey. Although only that portion of Shasta County southwest of Igo and Shasta Bally was included in this work, the understanding of the regional geology and structure of the Klamath Mountains derived from it forms an invaluable framework of reference for the geologist studying the Klamath Mountains in Shasta County.

In 1957, geologists of the Division of Mines began reconnaissance geological mapping of an extensive area in northeastern California as part of a program of compiling and mapping the geology of the entire State. By mid-1964, the four map sheets that include portions of Shasta County had been published (Gay and Aune 1958; Lydon *et al.*, 1960; Strand, 1962 and 1963); as a result, new, previously unpublished mapping covering more than half of Shasta County has been made available.

A continuing project by the U. S. Geological Survey to map a wide strip across the Cascade Range province resulted in 1964 in the publication of a map of the geology of the Manzanita Lake quadrangle (Macdonald, 1963), the first of a projected series.

As an outgrowth of the research into published and unpublished materials on the geology of California, resulting from the State Geologic Map program, the Division of Mines and Geology has published a series of indices listing more than 1,000 geological maps of areas in California that have been published in the literature since 1849, and about 1,200 unpublished graduate theses prepared since 1891 (Strand *et al.*, 1958; Koenig, 1962; Jennings and Strand, 1963); many studies of areas entirely or in part within Shasta County are included in these listings.

In 1966, the Division of Mines and Geology published its Bulletin 190, "Geology of northern California" (Bailey, 1966); several articles in this publication deal in part with the geology of Shasta County.

Mineral Resources and Production

Mineral Resources

The mineral resources of Shasta County include thirty commodities that have been mined or else occur in potentially economic quantities.

Placer gold has been recovered from the Red Bluff Formation and from most of the principal streams and many of the lesser tributaries in the Klamath Mountains and in the Great Valley west of the Sacramento River. Occurrences of lode gold are almost as widespread. The Midas and Bell Cow mines are in rocks of the Chanchelulla Formation in the western Paelozoic belt, and important lode districts are in the eastern Paleozoic and Triassic belt. Gold in the French Gulch district occurs principally in veins in the Bragdon Formation, although significant deposits also have been found at the contact with the underlying Copley Greenstone or associated with dikes of "birdseye porphyry". In the Mule Mountain area, gold is found associated with small intrusive masses thought to be correlative with the Shasta Bally batholith. Deposits of the Old Diggings district northeast of Buckeye are associated with flows and pyroclastic debris of the Balaklala Rhyolite interbedded with Copley Greenstone, the dominant rock type of the area. The Whiskeytown district encompasses a wider variety of rock types than do the above districts, and as a result gold mineralization is here related to Bragdon-"birdseye" contacts, quartz veins in the Mule Mountain stock, Balaklala Rhyolite, and Copley Greenstone.

Albers (1961) has studied in detail the gold deposits of the French Gulch district. He notes that the Bragdon Formation rests with structural discordance on underlying rocks in most places and infers from this that it overlies a thrust fault. He notes further that gold deposits occur along either steeply dipping veins in the Bragdon Formation or gently dipping veins at the thrust contact; in contrast, gold mineralization in the underlying Copley and Balaklala has been relatively sparse. Albers (1961, p. 3) concludes that "inasmuch as the gold in the rich veins in the Bragdon came from ascending solutions, it represents a residue that must have come past the favorable contact, and the possibility of finding additional ore at depth in mines that have not penetrated to this contact appears promising."

Between 1896 and 1965, Shasta County mines have yielded almost 704 million pounds of copper metal, more than half the statewide production during the same period. Almost all of this was mined from two major copper-zinc districts and from one mine (the Greenhorn) situated well outside them. The principal ore controls in the West Shasta copper-zinc district, which extends from Iron Mountain to Backbone Creek, are: 1) stratigraphic control within the middle unit of the Balaklala Rhyolite; 2) association with the axes of folded rock (although some ore bodies occur on the flanks of folds), especially where steeply dipping fracture cleavages intersect flat-lying foliation controlled by bedding; and 3) association with major faults or shear zones. In the East Shasta copper-zinc district, ore is localized along shear zones in the Bully Hill Rhyolite and fault contacts between the Pit Formation and Bully Hill. In both districts, copper occurs in deposits of massive sulfide ore that also contain zinc, lead, silver, and gold; cadmium was recovered during smelting of zinc ore at the Mammoth smelter during 1917–1918. Zinc was not recovered during most mining operations unless it occurred in quantity sufficient to offset the cost of making an additional zinc concentrate; the metal was recovered from zinc-rich ore at the Mammoth, Iron Mountain, Afterthought, Bully Hill-Rising Star, and Copper City mines. At Iron Mountain, massive sulfide deposits have been mined for their pyrite content, used in the manufacture of sulfuric acid.

Silver occurs not only in the massive sulfide ore, but also in the South Fork district northwest of Igo. Here it is associated with quartz veins in the Shasta Bally batholith, most of which strike northeast and dip steeply southeast. In addition, some silver usually occurs alloyed with gold and has been recovered in the course of ordinary placer or lode-gold mining.

Ultramafic rocks exposed in the northwestern corner of the County contain deposits of chromite that have yielded almost 29,000 tons of ore; most of this has come from the Little Castle Creek mine. Chromite occurs as massive pods and lenses, and as concentrations of disseminated grains in dunite that locally is serpentinized. This same expanse of ultramafic rock contains deposits of chrysotile and anthophyllite asbestos, notably northwest of Gibson and along Mears Creek.

In Trinity County, a few miles west of Gray Rocks on the Shasta County line, is the Altoona mine, from which more than 30,000 flasks of mercury have been mined. Mercury ore occurs here at the contact between serpentine and "feldspar porphyry". Inasmuch as a similar basic intrusive mass occurs in the ultramafic rock north of Mears Creek between Gray Rocks and the Sacramento River, the possibility exists that some mercury mineralization may be found along its contacts, although none has yet been reported.

Relatively fresh dunite in the vicinity of the Little Castle Creek and Lucky Strike chromite mines contains masses of fresh, coarse-grained olivine that may have some potential for mining as a source of foundry sand or refractory material. An aplite dike in peridotite two miles west of Gibson contains disseminated flakes of molybdenite. This mineral ordinarily is associated with acidic rather than ultramafic igneous rocks. Hence, any search for additional deposits of molybdenite should be directed toward finding similar dikes of aplite or pegmatite, rather than toward investigation of the ultramafic rock itself.

Talc and mercury are minerals frequently associated with ultramafic rocks, but the only recorded occurrences in Shasta County are in metavolcanic rock. Steatite-grade talc occurs at the Ganim mine near

Whiskeytown in a wide shear zone along which the host rock of Copley Greenstone is intensely altered, and sparse cinnabar is reported in an altered zone in Bully Hill Rhyolite a few miles northwest of Whitmore.

Iron, in the form of massive magnetite, occurs principally in contact metamorphic deposits associated with the McCloud Limestone and an intrusive dike of augite-quartz diorite. Small, isolated bodies of broken but massive magnetite with some hematite are present in the Balaklala Rhyolite near Iron Mountain, and a deposit of spongey hematite occurs in metavolcanic rock (Dekkas Formation?) near Cove Creek, on the south shore of Shasta Lake northeast of Gray Rocks.

Tungsten is locally associated with auriferous quartz veins in the French Gulch district and the Lower Springs district southeast of Shasta, where small disseminated masses and veinlets of scheelite are found in massive quartz. Host rocks in which the veins occur are Copley Greenstone and Bragdon Formation.

Manganese oxide is associated with chert and quartzite (metachert) of the Chanchelulla Formation in the southwestern corner of Shasta County. Several miles west of Ono, a manganese deposit containing psilomelane, pyrolusite, and minor rhodonite occurs in biotite schist of the Abrams Formation, together with interbedded fine-grained quartzite or metachert. Psilomelane and pyrolusite also are found in sheared metavolcanic rock (metadacite of Pit Formation?) at Cove Creek northeast of Gray Rocks.

Four major belts of limestone are present in the Klamath Mountains province in Shasta County; each is crudely arcuate, concave east, and trends north to north-northeast. The western belt is the least well-defined of the three, and consists of scattered, irregular outcrops of limestone of the Kennett Formation west of Shasta Lake and a few miles southeast of Castella. The second belt, the largest and most continuous of the three, is composed of McCloud Limestone; the quarry of Calaveras Cement Company is in this formation at Gray Rocks. The third belt extends from Highway 299 a few miles east of Ingot to Brock Mountain and northward along North Fork Squaw Creek; it consists of the Hosselkus Limestone. An isolated group of limestone exposures along Highway 299, which have been assigned to the Pit Formation (Albers and Robertson, 1961, p. 37), comprises the eastern belt and is the smallest of the four. Although the McCloud Limestone is the only belt in which an active quarry was situated in 1963, quarries had produced rock for fluxing material or lime from each of the belts during the early part of this century.

Shasta County contains widespread Holocene stream-bed deposits of sand and gravel, especially along the Sacramento River and its major tributaries south and in the vicinity of Redding. Volcanic sand and gravel deposits occur west of Viola, south of Old Station Post Office, along the west margin of Hat Creek Valley, and in several other scattered basins of deposition in the eastern part of the county. Other materials that have been utilized as sources of sand and gravel, chiefly for highway construction, are sands of the Montgomery Creek Formation, Pliocene continental deposits near the junction of Hat Creek and the Pit River, post-Tuscan-Formation gravel (Red Bluff Formation?) east of Palo Cedro, dredge tailings at French Gulch and along lower Clear Creek, and floodplain, terrace, and older channel deposits along the Sacramento River from near Dunsmuir to Anderson.

Crushed stone has been produced for use in road construction from basaltic and andesitic flows in the eastern half of the county, metamorphic rock in the Klamath Mountains province, the Midas gold mine dump (quartz and greenschist) at Knob, and the large dump of granitic rock resulting from driving of the Spring Creek tunnel.

Dimension stone, quarried around and before the turn of the century, has been obtained from such diverse sources as the quartz diorite near Igo, massive Cretaceous sandstone a few miles southwest of Redding, and gray welded tuff near Millville. Modern home and commercial construction and landscaping in northern California is making increasing use of dimension and decorative stone, and Shasta County contains many rock types that are well-suited to this use. Among these are massive portions of the Copley Greenstone, granitic rock of several types, sandstones of diverse appearances including fossiliferous and nonfossiliferous types, white pumice tuff, massive tuff breccia of the Tuscan Formation, and volcanic flows from which can be obtained rock varying widely in color, size, and other physical characteristics.

Volcanic cinders are mined from several cinder cones between Burney Mountain and Hat Creek Post Office, widely scattered deposits east of Hat Creek Valley and south of Fall River Mills, and the prominent cone and associated cinder field of Black Butte, southwest of Shingletown. Some deposits yield red cinders, whereas others contain black, black and tan, or black and red. The average size of cinders also varies somewhat among deposits or even among different portions of the same deposit. They are used for aggregate, road base, drainage fill, decorative stone, and in lightweight building block.

Barite is common as a gangue mineral in the Bully Hill mines and is exposed as pods and lenses in the Bully Hill shear zone. Southeast of Bully Hill, barite replaces a bed of metamorphosed tuff in the Pit Formation. East of Castella, brittle, black barite is associated with metamorphosed tuff and siliceous sediments of the Kennett Formation; locally it is finely interbedded with laminated siliceous rock that originally may have been deposited by submarine mineral springs. Northeast of O'Brien, veins of barite up to eight feet wide occur in the Baird Formation adjacent to fine-grained gabbro.

Diatomite is widespread in Pliocene sediments northeast of Burney and in the vicinity of Lake Britton. It occurs in massive beds of relatively pure diatomite and with admixtures of volcanic ash and sedimentary material. During the 1920's it was used locally as insulating material in commercial refrigerators. Other possible uses are as an insecticide carrier, soil conditioner, or raw material for lightweight concrete block.

Coal of lignitic to sub-bituminous grade occurs in widely scattered locales in Shasta County, in beds a

few inches to a few feet thick with partings, seams, and interbeds of clay and shale. Southwest of Platina it is found in sediments of Early Cretaceous age, whereas it occurs in the Eocene Montgomery Creek Formation northeast of Big Bend. The most extensive deposits are southeast of Ingot, where light, blocky lignite and lustrous, sub-bituminous coal are present in sediments of Eocene (or Cretaceous?) age.

Prospecting for natural gas has been conducted at several locales in Shasta County, but no production has as yet resulted. Farther south in the Great Valley, natural gas has been obtained from marine Upper Cretaceous rocks similar to portions of the Chico Formation exposed east of Redding and from continental sediments of the Tehama Formation.

Hot or cold mineral springs are common in Shasta County, but only those at Big Bend, northeast of Castella, and near Montgomery Creek have been developed commercially. In 1964, only one firm was producing bottled water in Shasta County; the water was obtained from a well in Enterprise and was treated to meet specifications of the California Department of Public Health.

Manufacture of clay brick was once an important industry in the county. Kilns were operated at Anderson and Redding, and clay was obtained from deposits south of Redding, near Anderson, and north of Centerville. Reddish clay of the Red Bluff Formation and buff, gray, and greenish clays of the Tehama Formation are potential sources of common clay in Shasta County.

An occurrence of graphite is reported at Cove Creek, where carbon-rich lenses and pods of rock are found in a vertical shear zone in the Pit Formation. There has been no production.

Sulfur is known to occur in Lassen Volcanic National Park, associated with gaseous hot springs. A small amount of sulfur may have been extracted from this area before the turn of the century, but it is now closed to mineral entry or location.

Rocks and minerals suitable for display or lapidary processing have been known in Shasta County for many years, and undoubtedly some of this material has been removed at a small but constant rate over the years. Only in 1961, however, was any "production" reported, when $5 worth of "gemstones" (calcite) appear in the annual statistics. There are 78 minerals reported from Shasta County (Collins, 1960, pp. 60–61) in addition to a wide variety of rock types, providing ample raw material for the collector or lapidarist.

A summary of the economic geology of Shasta County appears in table 1.

Mineral Production

Shasta County yielded a total of $294,605,000 in mineral production during the interval 1880–1969. The amount of production and the particular commodities produced prior to 1880 are not known, but undoubtedly gold was dominant, and there probably was some recovery of silver alloyed with the gold. Copper was mined at Copper City in the 1860's; dimension stone was quarried near Millville during the 1870's; and it seems likely that construction materials (clay brick, stone; some lime?) had been produced and consumed locally at many locales in Shasta county ever since the 1850's. Details of mineral production from 1880 to 1969 appear in table 2.

Copper is the principal mineral commodity of Shasta County, accounting for almost half of the total value of production ($112 million), whereas gold comprises but a fifth ($46 million). Silver, miscellaneous stone, sand and gravel, and zinc have production totals ranging from 10 to 18 million dollars. More than 4 million dollars in pyrite were produced up to 1920, but since then the annual production figures have been concealed; inasmuch as this value accounts for only 1.2 million of the four million tons of pyrite produced up to 1957 (California Div. Mines, 1958, p. 3) from the Iron Mountain mine alone, it seems reasonable to assume that, by the end of 1962, the total value of production for pyrite was more than 20 million dollars. Lead and limestone have each accounted for about a million dollars of production. Less than a half million dollars each in production is attributed to brick, chromite, lime, and mineral water. Miscellaneous and unapportioned commodities for the various years comprise a total of about 50 million dollars.

Trends in mineral production in Shasta County become apparent by inspection of table 1. Gold was produced steadily from 1880 to 1941, with peaks of production during 1908–1915 and 1936–1941; since then it has declined steadily. The value of gold mined each year since 1951 has been lower than for any year during the seven preceding decades since 1880. The amount of gold recovered in Shasta County prior to 1880 is not known, although statewide production is estimated to have reached its peak values during the early and middle 1850's. Inasmuch as contemporary literature did not regard the northern diggings with great favor, it may well have been that mining exploration and development proceeded at too slow a pace in Shasta County to share in the early booms.

Copper—the mainstay of Shasta County mineral production—was produced from 1896 to 1969. During the years 1897–1919 and 1924–1925, production exceeded 5 million pounds annually.

Silver, like gold, has been produced steadily since 1880 (and undoubtedly earlier). Years of recorded peak production were 1880 and 1898–1919; the annual value of metal recovered has declined sharply since 1952. The statistics make it apparent that production of silver has been closely allied with that of copper rather than of gold. The position of silver in the monetary system of the United States undoubtedly had some effect on its production. The decline evident during 1880–1886 may have been part of a general downward trend following the Gold Resumption Act of 1875 and full convertibility of greenbacks to gold beginning in 1879.

Platinum production is recorded during 1917–1941, 1948, and 1950–1951. Statistics are not listed separately after 1927, but the peak of production prior to that time was 496 fine ounces in 1922. Most platinum has been recovered as a by-product of placer gold mining.

Table 1. Summary of the economic geology of Shasta County.

ERA	PERIOD	EPOCH	UNIT	ROCK TYPES	POTENTIAL or ACTUAL MINERAL RESOURCES
CENOZOIC	QUATERNARY	Historic Time	dredge tailings	Sand, gravel, and cobbles	Sand and gravel
			lava flows in Lassen Peak area	Volcanic flows, mud flows, and avalanche debris	
		Pleistocene and Holocene	alluvium	Sand, silt, soil, and minor surficial debris	
			channel deposits	Silt, sand, and gravel	Sand and gravel, gold, platinum
			terrace deposits	Sand and gravel	Sand and gravel, gold
		Pleistocene	glacial deposits	Moraines and outwash deposits	Sand and gravel
			lava flows of Cascade Range	Basalt and associated cinder cones; andesite and dacite	Cinders, dimension stone
			Red Bluff Fm.	Clay, sand, and gravel	Sand and gravel, gold, brick clay
	TERTIARY	Upper Pliocene	pumice tuff north of Manton	White pumice tuff	Decorative stone, lightweight aggregate
			lava flows of Cascade Range	Basalt, andesite, and minor dacite ash and plugs	Dimension and crushed stone
			Tuscan Fm.	Tuff breccia; interbedded flows, tuff, sand and gravel; basal welded tuff unit	Ground water and dimension stone
			Nomlaki Tuff Member	Pink to light gray dacitic tuff	Dimension stone, lightweight aggregate, pozzolanic additive
			Tehama Fm.	Pebbly and tuffaceous sandstone; clay and conglomerate	Ground water, natural gas, sand and gravel, clay
			continental sediments east of Burney	Diatomaceous and ashy sandstone	Diatomite, sand and gravel
		Eocene	Montgomery Creek Fm.	Light-colored, loosely consolidated clay, sandstone, and conglomerate	Coal, sand and gravel
MESOZOIC	UPPER CRETACEOUS		Chico Fm.	Massive, buff colored sandstone and friable shale	Dimension stone, natural gas
			Bald Hills Fm.	Conglomerate, graywacke, and mudstone	
	LOWER CRETACEOUS		Ono Fm.	Mudstone, siltstone, and dark gray feldspathic sandstone; includes Roaring River Tongue (conglomerate) and Huling Tongue (graywacke)	Dimension stone, coal
			Rector Fm.	Biotite sandstone, conglomerate, and mudstone	
	UPPER JURASSIC to LOWER CRETACEOUS		Shasta Bally batholith and other bodies of granitic rocks	Biotite quartz diorite; porphyritic granodiorite, gabbro, and diorite	Gold, silver, dimension stone
			granitic dikes and quartz veins	"Birdseye" porphyry of dioritic to dacitic composition, aplite, and quartz	Gold, silver, base metals, molybdenum
	UPPER JURASSIC		ultramafic rocks	Peridotite, with dunite and pyroxenite important locally; serpentinized in part	Chromite, asbestos, mercury, olivine, talc
			mafic quartz diorite	Augite-quartz diorite	
			granitic rocks of Mule Mountain and Pit River stocks	Trondhjemite and albite granite	
	MIDDLE JURASSIC		Bagley Andesite	Massive greenstone pyroclastic rocks and flows	
			Potem Fm.	Tuffaceous sandstone, tuff, and limestone	
	LOWER JURASSIC		Arvison Fm.	Massive greenstone pyroclastic rocks and flows; some conglomerate	
	TRIASSIC		Modin Fm.	Volcanic breccias, flows, tuffs, and interbedded sediments; includes Hawkins Creek (breccias, flows, conglomerate), Devils Canyon (limestone, calcareous sediments), and Kosk (breccias, argillites, tuffaceous sandstone) Members	
			Brock Shale	Argillite and tuffaceous sandstone	
			Hosselkus Limestone	Hard, massive, fossiliferous limestone; siliceous in upper part	Limestone
			Pit Fm.	Black slate, siltstone, and interbedded limestone and tuff	Limestone, crushed stone, massive sulfide ore (zinc, copper, silver, lead, gold, pyrite), manganese, barite, graphite
			Bully Hill Rhyolite	Metadacite, and shaly metatuff	Massive sulfide ore (zinc, copper, silver, lead, gold, pyrite), mercury
PALEOZOIC	PERMIAN		Dekkas Fm.	Massive greenstone composed of keratophyric and spilitic flows and pyroclastic rocks; some interbedded siliceous mudstone	Hematite, copper
			Nosoni Fm.	Tuffaceous metasediments with minor interbedded tuff breccia	
			McCloud Limestone	Bedded light gray limestone; locally fossiliferous, siliceous, or dolomitic	Limestone, contact metasomatic ore (chiefly magnetite, minor chalcopyrite)
	MISSISSIPPIAN		Baird Fm.	Metamorphosed pyroclastic rock, flows, siliceous mudstone, and limestone	Barite
			Bragdon Fm.	Black slate, metaconglomerate, grit, and metatuff	Gold, tungsten, barite (?)
	MIDDLE to LOWER UPPER DEVONIAN		Kennett Fm.	Siliceous or tuffaceous mudstone; limestone	Limestone, barite (?)
	PRE-MIDDLE DEVONIAN		Balaklala Rhyolite	Massive or foliated, light gray to greenish metavolcanic flows and pyroclastic rock of quartz-keratophyric composition	Massive sulfide ore (copper, zinc, silver, lead, gold, cadmium, pyrite), gold, magnetite, barite
			Copley Greenstone	Massive greenstone composed of keratophyric and spilitic flows and pyroclastic rocks	Gold, minor massive sulfide ore (copper, zinc, lead, pyrite), talc, tungsten, dimension stone
STRATIGRAPHIC POSITION UNCERTAIN	PERMIAN		Chanchelulla Fm.	Chert, mica schist, quartzite, phyllitic slate, and metaconglomerate	Gold, manganese
	PRE-CRETACEOUS		Abrams Fm.	Mica schist and siliceous metasediments; portions renamed as Grouse Ridge and Stuart Fork Formations, respectively above and below the Salmon Fm.	Manganese
			Salmon Fm.	Dark green hornblende schist and chlorite schist	

Pyrite was mined continuously from 1902 to 1962, but the value has not been recorded separately since 1921 and therefore no trends are apparent. Because pyrite is used solely for the manufacture of sulfuric acid, a commodity with wide applications in industry, it seems reasonable to assume that trends of production were similar to general economic trends for the nation as a whole. In recent years, however, sulfur has been produced in increasing quantities from a variety of other sources, and the economic advantage enjoyed by Shasta County pyrite deposits because of their proximity to the San Francisco Bay area has steadily decreased.

Chromite and manganese have been mined in Shasta County for brief periods, principally during years of national conflict. Chromite was produced from 1894 to 1918, with a peak in 1916; there has been minor production in every decade since. Manganese was produced in 1916 and during 1943–1944.

Iron ore, principally magnetite, was produced intermittently from 1894 to 1910; later major periods of production were 1914–1926 and 1942–1946, and some additional production was recorded during 1953–1954 and 1962–1965. The Noble Electric Steel Company operated an electric arc furnace at Heroult from 1907 to 1918, and until 1914 it produced pig iron exclusively. The company continued to mine iron ore from the Shasta Iron mine following the closing of their furnace. During World War II, about 100,000 tons of iron ore were mined each year for use as ship ballast.

Lead and zinc have been recovered from the massive sulfide deposits that are also the source of Shasta County's copper and pyrite. Lead was recovered—principally as a by-product—during the years 1910 to 1959; peak production of more than a million pounds was attained in 1947 and 1951–1952, coinciding with the maximum post-war price for the metal. Zinc was recovered during 1915–1927 and 1943–1956; the annual production exceeded three million pounds of metal for 13 of the 17 years for which figures are available.

Mineral commodities used in construction include clay brick, lime, limestone, sand and gravel, and miscellaneous stone. Brick was manufactured in Shasta County from 1896 to 1920, but the annual value never exceeded $30,000 except in 1907, when 4.5 million bricks worth $33,000 were manufactured. Lime and limestone were produced during the intervals 1896–1927 and 1961–1969; the peak annual production of lime during the first interval was reached in 1907 ($31,900), and that of limestone during 1909–1910 (more than $100,000). The magnitude of the recent operation of Calaveras Cement Company is indirectly reflected in the statistics, inasmuch as the value of "miscellaneous and unapportioned" production during 1962 was almost five times that of the preceding year, due in large part to production of cement. The high level of production value in this category increased steadily during 1963–1969.

Miscellaneous stone has been produced in Shasta County from 1896 to the present time. Annual production exceeded $500,000 in 1924 and 1944, and ranged from 1.6 to 2.5 million dollars during 1941–1943. This latter peak in production is attributable to the construction of Shasta Dam, which utilized more than 12 million tons of sand and gravel. Beginning in 1947, production of sand and gravel is tabulated separately; as might as expected in view of the increased tempo of large-scale public works and of commercial and residential construction, the annual value has increased steadily in recent years. It exceeded a million dollars in annual value in 1957 and during 1959–1968.

Production of sandstone is recorded during 1938 and 1940–1942; that of volcanic rock occurred intermittently during the 1930's; and that of volcanic cinders has been recorded continuously since 1954. In most cases, specific data are concealed under "miscellaneous and unapportioned".

Other non-metallic commodities include: asbestos, production of which is recorded intermittently from 1913 to 1951, with principal intervals of production during 1920–1924 and 1944–1951; barite, mined intermittently from 1919 to 1969, but principally during 1921–1923 and 1963–1969; diatomaceous earth, with production recorded from 1924 to 1929; coal, mined during the 1920's; talc, mined during the 1920's and 1940's; and mineral water, bottled during the years 1894–1919 (the height of popularity of spas and "taking the waters") and 1942–1946, with production exceeding 100,000 gallons in 1894 and during 1908–1909.

Minor mineral commodities for which production is recorded include silica (1916–1917), molybdenum (1917–1918), cadmium (1917–1918), gemstones (1961–1962), and mercury (?) in 1965.

A summary of the economic geology of Shasta County appears in table 1.

Table 2. Mineral production of Shasta County, 1880–1969.

Year	BRICK		CHROMITE		COPPER		GOLD	LEAD		LIME		LIMESTONE		MINERAL WATER	
	Thousand	Value	Tons	Value	Pounds	Value	Value	Pounds	Value	Barrels	Value	Tons	Value	Gallons	Value
1880							$140,455								
1881							350,000								
1882							300,000								
1883							210,000								
1884							320,000								
1885							417,004								
1886							699,508								
1887							627,681								
1888							600,000								
1889							415,631								
1890							420,530								
1891							554,063								
1892							574,833								
1893							500,407								
1894			1,200	$16,800			617,436							150,000	$75,000
1895			90	1,120			718,696								
1896	300	$1,500			1,847,087	$184,708	599,209			2,310	$2,541				
1897	1,200	7,200			13,592,610	1,535,966	569,071			2,100	2,100	9,000	$13,500		
1898	1,200	7,200			21,422,000	2,465,830	860,180			2,500	3,750			3,000	2,000
1899	2,000	14,000			21,835,863	3,565,023	873,719			8,000	10,000	250	375	5,000	1,850
1900	2,000	12,000	140	1,400	25,736,473	4,166,735	733,467			17,850	17,850	1,150	1,150	9,640	5,784
1901	3,000	12,000	130	1,950	30,990,781	4,881,048	927,975			21,600	12,960			26,295	7,644
1902	2 450	12,250	315	4,275	21,515,887	2,496,731	878,706			18,500	12,500	3,500	3,600	26,295	7,645
1903	3,500	17,500	150	2,250	16,453,409	2,171,497	771,242			27,000	10,800	5,400	5,400	40,000	12,000
1904	3,000	15,000	98	1,470	26,438,145	3,439,974	1,031,429			18,000	10,500				
1905	3,500	14,000	20	300	10,830,865	1,688,614	684,952			10,700	8,000	3,600	3,600	80,000	12,000
1906	4,400	22,000	80	1,200	22,477,304	4,338,121	819,144			12,860	8,040	27,000	32,960		
1907	4,500	33,000	260	5,200	27,844,364	5,568,873	791,997			29,222	31,900	30,761	30,761		
1908	2,000	12,000	280	5,600	34,878,677	4,642,976	1,131,832			11,818	9,100	80,000	80,000	100,000	20,000
1909	3,500	23,500	205	3,517	58,665,447	7,581,115	1,600,489			8,650	8,000	129,560	134,595	100,000	20,000
1910	2,425	17,548	680	9,155	44,947,950	5,725,469	1,533,728	1,859	$83	16,616	14,114	117,109	117,083	40,000	10,000
1911	2,825	20,094	875	13,697	29,539,913	3,692,489	1,059,881	881	40	13,271	10,164	67,924	65,253	25,000	6,250
1912	1,697	10,195	1,000	8,000	25,249,892	4,166,232	986,803			6,529	3,548	58,022	45,575	23,225	5,646
1913	360	4,330	280	2,800	27,686,436	4,291,708	1,208,870	19,070	839	8,595	7,030	41,346	35,616	30,000	6,850
1914	1,594	10,223	867	4,884	25,122,766	3,341,328	1,101,202	21,565	841	8,657	5,163	36,997	30,026	30,000	6,850
1915	1,836	11,550	1,757	17,570	30,828,917	5,395,060	1,120,848	180,936	8,504	[2]		44,953	40,945	12,000	1,800
1916	[2]		12,425	181,225	39,437,196	9,701,550	936,885	478,560	33,021	[2]		[2]		[2]	
1917	[2]		3,116	68,479	28,009,990	7,646,727	775,125	8,725	750	[2]		[2]		[2]	
1918	[2]		1,423	70,214	25,294,590	6,247,764	543,509	492,565	34,972	[2]		45,671	72,410	[2]	
1919	[2]				8,673,242	1,613,242	378,283	[2]		[2]		[2]		[2]	
1920	[2]				810,843	149,195	312,901	64,400	5,152	[2]		[2]			
1921					437,593	56,449	267,681	[2]							
1922					1,827,875	246,763	393,034	[2]							
1923					3,437,963	505,381	359,487	328,115	22,968	[2]		[2]			
1924					21,109,958	2,765,405	346,622	6,615	529			28,097	36,480		
1925			[2]		14,565,967	2,068,367	235,013	647,886	56,366			24,395	28,480		
1926					5,113,114	715,836	132,906	15,584	1,247			[2]			
1927					4,524,906	592,763	191,900	1,780	112			[2]			
1928			[2]		3,049,910	439,194	113,132	4,400	255						
1929			[2]		6,066,098	1,067,633	89,689								
1930					3,962,383	515,110	226,214								
1931					309,314	28,148	331,165	[2]							
1932					295,981	18,647	529,935								
1933					885,108	54,727	618,290	14,883	551						
1934					388,775	31,102	718,583	[2]							
1935			[2]		6,178	513	962,448	1,747	70						
1936					[2]		1,304,590	[2]							
1937					88,985	10,767	1,773,275								
1938					[2]		1,439,620	[2]							
1939					[2]		1,566,810	3,790	178						
1940					1,714,324	193,719	1,479,135	1,995	100						
1941			[2]		116,412	13,737	1,719,760	[2]							

PYRITE		SAND AND GRAVEL[1]		SILVER	MISCELLANEOUS STONE[1]	ZINC		MISCELLANEOUS AND UNAPPORTIONED			TOTAL	
Tons	Value	Short tons	Value	Value	Value	Pounds	Value	Amount	Value	Substance	Value	Year
				$117,907							$258,362	1880
				85,000							435,000	1881
				80,000							380,000	1882
				20,000							230,000	1883
				30,000							350,000	1884
				9,223							426,227	1885
				10,647							710,155	1886
				40,204							667,885	1887
				50,000							650,000	1888
				5,396							421,027	1889
				7,279							427,809	1890
				7,432							561,495	1891
				7,977							582,810	1892
				8,577							508,984	1893
				5,032				200 tons	$1,500	Iron ore	715,768	1894
				28,417							748,233	1895
				24,233	$1,400						813,591	1896
				96,869							2,224,706	1897
				171,768							3,510,728	1898
				196,213	375			100 squares	800	Slate	4,662,355	1899
				635,640							5,574,026	1900
				891,994	2,000						6,737,571	1901
3,202	$7,005			306,887							3,729,599	1902
2,500	5,500			203,991	1,500						3,201,680	1903
				399,660							4,898,033	1904
				167,548							2,579,014	1905
32,689	89,895			434,483							5,745,843	1906
65,788	197,364			370,211				400 tons	400	Iron ore	7,029,706	1907
93,677	539,553			517,596	25,000						6,983,657	1908
449,762	1,349,286			735,460	4,688			108 tons	174	Iron ore	[3]11,508,547	1909
									47,723	Unapportioned, 1900–1909		
31,683	126,692			648,905				579 tons	900	Iron ore	8,203,677	1910
47,885	151,602			386,991							5,406,461	1911
62,605	174,402			425,382							5,825,783	1912
72,071	194,409			448,031				47 tons	1,175	Asbestos	6,212,344	1913
									10,686	Other minerals		
69,438	195,362			346,706	125			1,436 tons	5,128	Iron ore	5,047,838	1914
[2]				459,566	1,418	8,378,401	$1,038,922		253,950	Iron ore, lime, pyrite	8,350,133	1915
[2]				1,115,471	800	9,484,800	1,270,963		57,303	Lime and limestone	13,639,508	1916
									342,290	Asbestos, brick, iron ore, manganese, mineral water, platinum, pyrite, silica		
[2]				520,703	800	8,281,516	844,715		78,101	Lime and limestone	10,244,869	1917
								14 oz.	1,100	Platinum		
									308,369	Brick, cadmium, iron ore, mineral water, molybdenum, pyrite, silica		
[2]				420,410	7,000	3,045,692	277,158	35 oz.	2,709	Platinum	8,098,671	1918
									422,525	Brick, cadmium, iron ore, lime, mineral water, molybdenum, pyrite		
138,046	497,398			165,802	31,750	[2]			29,100	Lime and limestone	2,776,803	1919
								121 fine oz.	21,075	Platinum		
									40,153	Barite, brick, iron ore, lead, mineral water, zinc		
135,399	475,330			36,563	32,650	[2]		158 fine oz.	27,004	Platinum	1,108,538	1920
									69,743	Asbestos, brick, iron ore, lime, limestone, zinc		
[2]				5,581	31,945	[2]		219 fine oz.	26,817	Platinum	841,062	1921
									452,589	Asbestos, barite, iron ore, lead, pyrite, zinc		
[2]				26,901	65,525	[2]		496 fine oz.	57,458	Platinum	1,513,591	1922
									723,910	Asbestos, barite, iron ore, lead, pyrite, zinc		
[2]				47,706	86,500			299 fine oz.	43,326	Platinum	1,563,387	1923
									498,019	Asbestos, barite, iron ore, lime, limestone, pyrite		
[2]				343,402	587,637	[2]		27 fine oz.	3,361	Platinum	4,754,664	1924
									671,228	Asbestos, coal, diatomaceous earth, iron ore, pyrite, zinc		
[2]				208,818	349,617	11,090,430	842,873	8 fine oz.	725	Platinum	4,300,449	1925
									510,190	Chromite, diatomaceous earth, iron ore, pyrite, talc		
[2]				110,719	162,355	17,757,000	1,331,775	28 fine oz.	3,034	Platinum	2,886,144	1926
									428,272	Coal, diatomaceous earth, iron ore, limestone, pyrite, talc		
[2]				70,261	134,678	[2]		25 fine oz.	2,552	Platinum	1,950,088	1927
									957,822	Diatomaceous earth, limestone, pyrite, talc, zinc		
[2]				39,431	137,034				385,683	Chromite, coal, diatomite, platinum, pyrite	1,114,729	1928
[2]				31,048	247,351				315,475	Asbestos, chromite, diatomite, platinum, pyrite	1,751,196	1929
[2]				5,442	228,778				135,602	Platinum, pyrite	1,111,146	1930
[2]				2,816	154,163			373 cu. ft.	950	Volcanic rock[4]	666,086	1931
				3,973	58,306				148,844	Barite, lead, platinum, pyrite		
									125	Unapportioned	610,986	1932
[2]				6,884	233,110				199,873	Platinum, pyrite	1,113,435	1933
[2]				16,816	147,070				231,609	Lead, platinum, pyrite	1,145,180	1934
[2]				23,805	72,850				290,576	Chromite, pyrite	1,350,262	1935
[2]				22,715	97,265				275,332	Copper, lead, platinum, pyrite	1,699,902	1936
				30,786	108,039				276,556	Unapportioned	2,199,423	1937
[2]				18,599	80,520				252,988	Copper, lead, platinum, pyrite, sandstone, volcanic rock[4]	1,791,727	1938
[2]				23,468	255,839				212,252	Copper, platinum, pyrite, volcanic rock[4]	2,058,547	1939
[2]				65,495	782,172				279,175	Platinum, pyrite, sandstone, talc	2,799,796	1940
[2]				18,327	1,678,020				329,004	Chromite, lead, platinum, pyrite, sandstone	3,758,848	1941

Table 2. Mineral production of Shasta County, 1880–1969—Continued

	BRICK		CHROMITE		COPPER		GOLD	LEAD		LIME		LIMESTONE		MINERAL WATER	
Year	Thousand	Value	Tons	Value	Pounds	Value	Value	Pounds	Value	Barrels	Value	Tons	Value	Gallons	Value
1942			[2]		[2]		[2]	[2]						[2]	
1943			[2]		1,380,149	179,419	75,670	9,523	714					[2]	
1944			398	18,974	2,585,656	349,063	62,860	500,509	40,041					[2]	
1945					3,777,988	510,028	167,790	57,599	4,954			[2]			
1946					3,912,947	633,897	448,875	27,110	2,955					[2]	
1947					1,396,000	293,160	[2]	1,634,000	235,296						
1948					156,000	33,852	403,830	106,000	18,974						
1949					653,900	128,818	280,280	589,900	93,204						
1950					428,200	89,066	272,125	375,500	50,692						
1951			[2]		879,800	212,912	118,230	1,388,200	240,159						
1952			[2]		663,700	153,355	25,900	1,208,800	194,617			[2]			
1953			2,976 (long ton units)	4,876	[2]		[2]								
1954			[2]		[2]		[2]								
1955			[2]		3,900	1,455	11,690	3,100	462						
1956					[2]		[2]								
1957			[2]				[2]								
1958			[2]		[2]		17,920								
1959					88,700	27,231	17,990	400	46						
1960							21,070								
1961							6,160								
1962							5,285								
1963							4,060								
1964						[2]	89								
1965						[2]	4,165								
1966							5,145								
1967							3,360								
1968						[2]	[2]	[2]							
1969						[2]	[2]								
Total	47,287	$277,090	28,765	$444,956	703,958,431	$112,634,492	$46,449,474	8,195,997	$1,048,692	244,778	$188,060	754,735	$777,809	700,455	$201,319

[1] Until 1947, Sand and Gravel values were included with those of Miscellaneous Stone.
[2] Value included under Miscellaneous and Unapportioned.
[3] Value for 1909 includes value of Unapportioned for 1900–1909.
[4] Stone produced from Lassen Volcanic National Park during 1931 and 1938–39 was erroneously listed as "granite" in previous compilations of production.
[5] Increase in silver production over preceding year due partly to being reported in coinage value rather than in commercial value.

PYRITE		SAND AND GRAVEL[1]		SILVER	MISCELLANEOUS STONE[1]	ZINC		MISCELLANEOUS AND UNAPPORTIONED			TOTAL	
Tons	Value	Short tons	Value	Value	Value	Pounds	Value	Amount	Value	Substance	Value	Year
				[2]	2,581,053				1,444,170	Asbestos, chromite, copper, gold, iron ore, lead, mineral water, pyrite, sandstone, silver	4,025,223	1942
[2]				22,725	2,259,567	477,474	51,567		1,177,055	Chromite, iron ore, manganese ore, mineral water, pyrite	3,766,717	1943
[2]				70,944	543,504	3,013,340	343,521		1,186,466	Asbestos, iron ore, manganese ore, mineral water, pyrite	2,615,373	1944
[2]				67,173	144,849	4,026,545	463,053		761,955	Asbestos, iron ore, limestone, pyrite	2,119,802	1945
[2]				80,916	298,852	3,851,278	469,856		484,862	Asbestos, iron ore, mineral water, pyrite, talc	2,420,213	1946
[2]		258,960	224,273	[2]	[2]	3,414,000	413,094		1,105,403	Asbestos, gold, pyrite, silver, stone	2,271,226	1947
[2]		490,722	440,953	17,137	[2]	892,000	118,636		647,052	Asbestos, platinum group metals, pyrite, and 128,410 tons stone	1,680,434	1948
[2]		634,057	549,514	69,185	[2]	4,120,800	510,979		495,392	Asbestos, iron ore, pyrite, stone	2,127,372	1949
[2]		310,800	171,245	37,846	[2]	2,772,400	393,681		584,964	Asbestos, platinum, pyrite, stone	1,599,619	1950
[2]		381,485	306,225	134,439	150,620	6,119,600	1,113,267		938,378	Asbestos, chromite, platinum, pyrite	3,214,230	1951
[2]		159,461	183,572	100,668	[2]	5,411,500	898,309		932,232	Chromite, limestone, pyrite, stone	2,488,653	1952
[2]		259,259	260,355		[2]				646,354	Copper, gold, iron ore, pyrite, stone (crushed)	911,585	1953
[2]		639,622	582,836	[2]	[2]				997,397	Chromite, copper, gold, iron ore, pyrite, silver, stone (crushed), volcanic cinders	1,580,233	1954
[2]		612,677	581,396	434		8,200	1,009	86,467 short tons	49,339	Volcanic cinders	1,726,412	1955
									1,080,627	Chromite, pyrite, stone (crushed), tungsten concentrates		
[2]		493,239	633,325	[2]	98,014	[2]		19,233 tons	50,125	Volcanic cinders	1,531,280	1956
									749,816	Copper, gold, lead, pyrite, silver, zinc		
[2]		1,022,124	1,263,505		49,647				785,328	Chromite, gold, pyrite, volcanic cinders	2,098,480	1957
[2]		482,564	755,336	105	135,969				766,867	Chromite, copper, pyrite, volcanic cinders	1,676,197	1958
		957,421	1,264,792	119	59,714				767,771	Unapportioned	2,137,663	1959
		1,152,094	1,450,883		38,870			5,197 short tons	10,394	Volcanic cinders	2,242,136	1960
									720,919	Unapportioned		
		1,997,782	2,762,484	55	102,266			43,068 short tons	86,136	Volcanic cinders	3,676,998	1961
									719,897	Unapportioned, and gemstones valued at $5		
		1,178,320	1,314,926	62	1,245,354			131,955 short tons	264,220	Volcanic cinders	6,166,232	1962
									3,336,385	Cement, copper, gemstones, lead, iron ore, pyrite, shale		
		898,659	1,047,583	24	495,308			1,847 short tons	11,082	Barite	6,017,746	1963
								100,179 short ons	201,518	Volcanic cinders		
									4,258,171	Cement, clay, iron ore		
		1,785,000	1,229,000	14	457,682			26,749 short tons	60,119	Volcanic cinders	6,729,158	1964
									4,979,228	Barite, cement, clay, copper, iron ore		
		1,584,000	1,528,000	25	724,074			26,771 short tons	27,355	Volcanic cinders	7,733,039	1965
									5,449,420	Barite, cement, clay, copper, iron ore, mercury(?)		
		2,691,000	2,529,000	16	[2]				6,387,562	Barite, cement, clay, diatomite, iron ore, stone, cinders	8,921,723	1966
		2,383,000	1,941,000	14	[2]				4,763,702	Barite, cement, clay, diatomite, stone, volcanic cinders	6,708,076	1967
		1,320,000	1,348,000	[2]	[2]	[2]			5,959,405	Barite, cement, clay, copper, diatomite, gold, lead, silver, stone, zinc, volcanic cinders	7,307,405	1968
		786,000	867,000	[2]	[2]				5,077,064	Barite, cement, clay, copper, gold, silver, stone, volcanic cinders	5,944,064	1969
1,204,745	$4,003,798	22,478,246	$23,235,203	$12,365,068	$15,193,623	92,144,976	$10,383,378		$67,399,385	Grand total	$294,605,000	

Description of the Mines and Mineral Deposits

Metallic Minerals

CADMIUM

Greenockite (CdS), the chief cadmium ore mineral, is associated in minute amounts with sphalerite in some of the zinc-copper ores of Shasta County. Bradley (1922) reports that "several" thousand pounds of the metal were recovered at the electrolytic zinc plant of the Mammoth Copper Company at Kennett during 1917–1918. Production figures for the Mammoth mine given by Kinkel *et al.* (1956, p. 133) indicate that more than 16 million pounds of zinc were recovered during these years. If one assumes that 16,000 pounds of cadmium were recovered, this would represent a cadmium-zinc ratio of only 1:1,000, far below the ratio of 1:200 cited by Bradley (1922) as average for zinc ores.

No cadmium production has been credited to Shasta County since then, but it is probable that some was obtained from zinc concentrates shipped to smelters in other states.

CHROMITE

Deposits of chromite occur in ultramafic rocks that crop out extensively in northwestern Shasta County. Most of the chromite produced to date has been lump ore mined from lenses or pods, but deposits of the disseminated type also are known.

The Little Castle Creek mine near the border of Siskiyou County had a production of about 15,000 tons of ore averaging 45 to 48 percent Cr_2O_3 from a single lens by the end of 1916. Chromite also was mined from deposits in the Forest Queen group on Boulder Creek and from the Prim and Dougherty group in the Shotgun Creek area prior to 1916.

A chromite concentrating plant was built at Castella in 1942, to concentrate chromite to at least the 35-percent-minimum grade then acceptable at the government stockpile. Some ore from the Forest Queen mine in Shasta County, the Costa Neely mines in Trinity County, and Lambert mine in Butte County was concentrated at the Castella plant in 1954. For a few years afterward, the mill operated almost exclusively on ore from the Lambert mine. Around 1958, the mill site was acquired by the State of California, and the equipment subsequently was sold at auction.

A summary description of the principal chromite mines and prospects in Shasta County has been prepared by Wells and Hawkes (1965).

Castella Mining and Milling Company (Castle Crags Chrome Company, H. T. & J. Company, Montrose Mining and Milling Company, Strategic Minerals Exploration Company) mill. Location: Sec. 16, T. 38 N., R. 4 W., M.D., at Castella.

The mill was built in 1942 by the Montrose Mining and Milling Company to do custom milling of material assaying less than the minimum grade of 35 percent Cr_2O_3 then accepted at the government stockpile. In August 1943, operation of the mill was taken over by the Strategic Minerals Exploration Company, and some ore from the Little Castle Creek, Forest Queen, and Costa deposits was milled. The Montrose Mining and Milling Company took possession of the mill again in November 1943, and the operation was shut down. In September 1951, it was taken over by the Castle Crags Chrome Company, and milling was resumed on ore from the Forest Queen and the Costa Ranch deposits. The first ore from the Lambert mine near Paradise in Butte County was milled in April 1952. The mill was idle for several months in 1952 and 1953 because of the illness and death of the operating partner. Helmke, Thomas, and Janssen purchased the mill in August 1953 and milled ore mined from their mine (Lambert) and from the Munko, Costa, and Neely deposits west of Castella in Trinity County. The name of the property was changed in 1955 from the H. T. & J. Company to the Castella Mining and Milling Company. Around 1958, the mill site was acquired by the State of California for inclusion in Castle Crags State Park, and the mill equipment subsequently was sold and shipped out of the county.

Forest Queen (Black Bird, Gray Eagle, North Star, Union Forest Queen) group. Location: Secs. 22 and 27, T. 37 N., R. 5 W., M.D., about two miles northwest of Gibson. Ownership: William A. Orsini, *et al.*, Redding, California, own six claims.

Irregular-sized orebodies in dunite were mined from adits, open cuts, and inclines during World War I. The main workings consisted of a crosscut driven 50 feet to a lens that strikes N. 40° W. The ore ranged from a few inches to four feet in width. It was stoped for a length of 150 feet and to a depth of 100 feet. Other adits were 15, 25, 50, and 135 feet in length. About 1,000 tons of ore averaging 43 percent Cr_2O_3 were mined from this property prior to 1918 (Bradley *et al.*, 1918, p. 182).

In 1952 the property was worked by the owner and two partners. An adit was driven N. 38° W. for 35 feet on the North Star claim and a cut made near the adit portal. These workings were the source of about 40 tons of ore, which had an average grade of 50 per-

Photo 3. Adit on the North Star claim of the Forest Queen group of chromite claims.

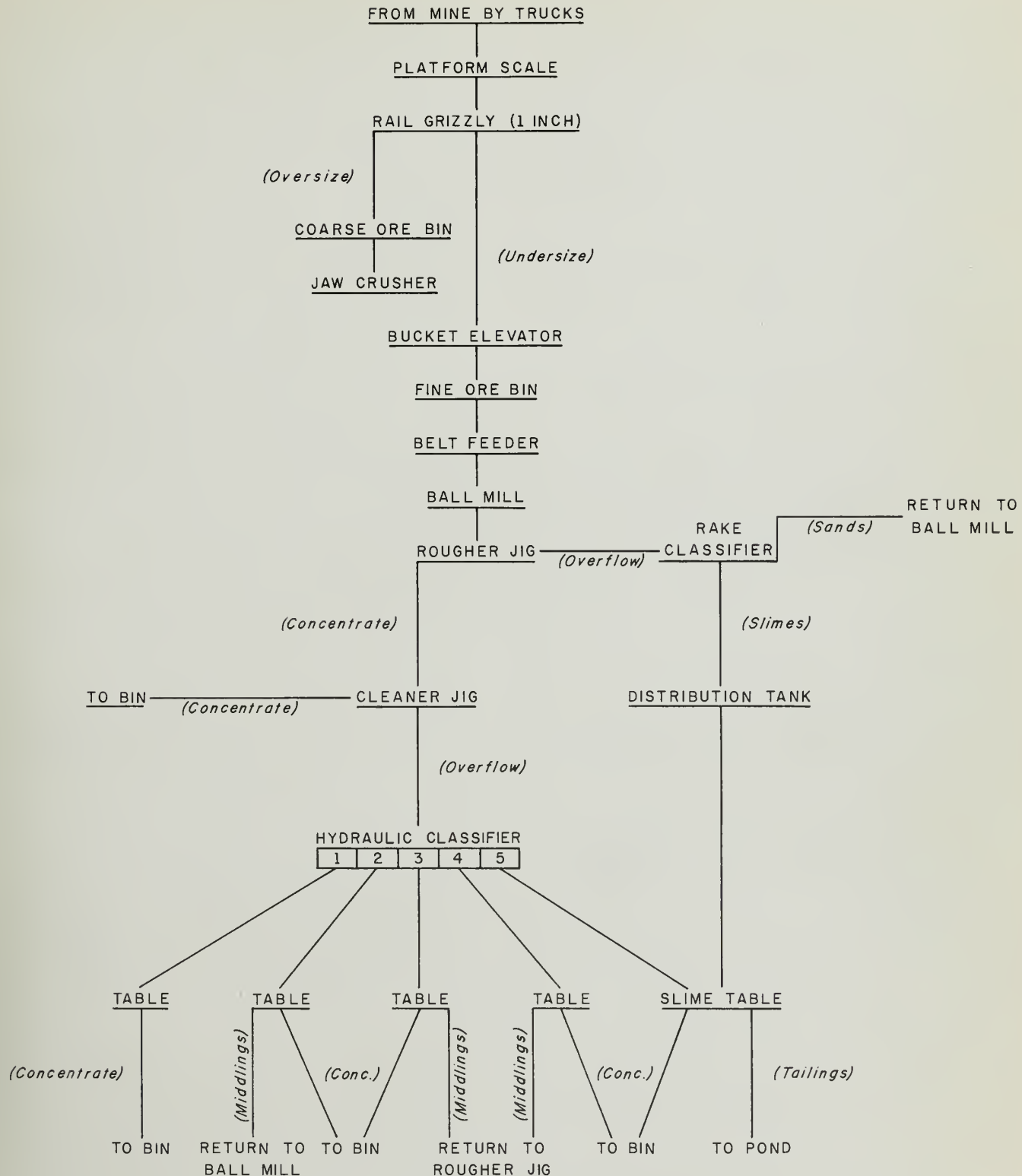


Figure 2. Chrome-mill flow sheet of Castella Mining and Milling Company.

cent Cr_2O_3 and a chrome-iron ratio of 2.27:1. The ore was shipped by truck to the government stockpile at Grants Pass, Oregon.

About 16 tons of milling grade ore were shipped to a mill at Ashland, Oregon. In September 1952, small amounts of sorted ore were piled near old surface cuts on the other claims.

In August 1954, the property was leased by Helmke, Thomas, and Janssen (H. T. & J. Company), and a few tons of ore containing from 41.8 to 44 percent Cr_2O_3 were mined. There has been no production reported since 1954.

Little Castle Creek (Brown, California Chrome Company) mine. Location: Sec. 2, T. 38 N., R. 4 W., M.D., about two miles southwest of Dunsmuir. Ownership: Mernice Johnson, Box 897, South Highway, Dunsmuir, California.

The property was first located in 1906 by L. H. Brown of Dunsmuir, who worked it until July 1915 and then sold it to the California Chrome Company. This company operated for about a year and was later dissolved.

The U. S. Geological Survey made a magnetometer survey of the property in 1941, and the indicated favorable area was prospected by the U. S. Bureau of Mines. Fifteen bulldozer trenches were dug, totaling 2,270 feet in length and ranging from two to seven feet in depth. In addition, ten trenches 10 to 100 feet long and from three to five feet deep were dug by hand. No continuity or pattern of mineralization was disclosed by the magnetometer survey. The average of 68 samples taken from the trenches, outcrops, and underground workings ranged from 0.71 to 25.79 percent Cr_2O_3 (Matson, 1949, fig. 2).

In May 1954, Helmke, Thomas, and Janssen leased the property, retimbered a portion of the upper adit, and bulldozed the bank above the creek looking for the source of float ore. No new orebody was found, and the work was discontinued.

Chromite occurs in lenses and as disseminations in serpentine and dunite; pink kammererite occurs in veinlets and interstitially with some of the chromite. The principal production came from a massive chromite lens that was 160 feet long in a N. 40° E. direction, from 20 to 40 feet wide, and more than 85 feet deep. It dips northwest and thins rapidly with depth. The grade of ore averaged 45 to 48 percent Cr_2O_3 (Bradley *et al.*, 1918, p. 187). The massive ore was bounded sharply on the east side by peridotite that was serpentized adjacent to the chromite, whereas the ore on the west side graded into disseminated, low-grade chromite. The orebody was characterized by numerous wedge-shaped seams of clay gouge that were oriented with the large ends of the wedges facing downward, so that timbering was attended by some difficulty.

About 75 feet below the main adit, there is a small open pit with an adit driven along the west edge for 80 feet. The chromite here is disseminated and in narrow seams in slightly altered dunite. Large fractures filled with brown clay trend N. 50° E. along the general course of the ore zone.

The large lens that was the principal source of production was worked by an open pit to a depth of 55 feet and for a strike length of about 40 feet. An adit from the pit floor penetrated ore for more than 75 feet in a southwesterly direction. Subsequently a lower adit was driven at a depth of 30 feet below the pit floor; it also penetrated to the southwestern limit of ore, and mining then was done by allowing the ground to cave as the workers retreated toward the portal. Most of the underground workings are now inaccessible.

Round Bottom (Beegum Chrome) mine. Location: Sec. 5, T. 28 N., R. 10 W., M.D., about seven miles southwest of Platina. Ownership: Dave Pierson, Igo, California, and Leland Pierson, Red Bluff, California.

Chromite here occurs in flat lenses and seams in badly fractured serpentine; it ranges in thickness from a fraction of an inch to nine feet.

In May 1941 the property was leased and operated by Donald Woodrum of San Francisco. About two miles of steep winding road were built to the property and a camp was built to accommodate 10 men.

An incline was driven N. 33° W. for 75 feet on a minus-9-degree slope. Chromite was cut about 20 feet from the entrance and followed for 55 feet. At about 30 feet from the entrance, a drift was driven S. 60° W. for 25 feet following a seam of chromite six to 20 inches thick. Woodrum said that he mined about 500 tons of ore from an area 40 feet long and with a maximum width of 40 feet, on the northeast side of the incline. The ore was shipped to the Metals Reserve Company at Sacramento and averaged 49 percent Cr_2O_3. The ground was very heavy and required close timbering and back-filling. By 1944 the incline had caved.

From July 1944 to September 1945, the property was leased to C. A. Wittington of Platina. From a point about 25 feet southwest of the old incline portal, a new incline was driven N. 45° W. for 135 feet. A crosscut was driven S. 67° W., 15 feet from the bottom of the incline, and a vertical winze was sunk 22 feet at the end. Stringers of chromite were cut between depths of nine and 11 feet in the winze.

The winze was filled to within four feet of the top and a drift was driven N. 80° W. for 25 feet at that elevation. A lens of chromite 18 inches wide, striking N. 65° W. and dipping 55° N., was cut at the face of the drift. Wittington shipped some ore to the Metals Reserve Company in Sacramento in 1945, but there has been no production reported since.

COPPER

Mining

The principal copper mines in Shasta County are in the West Shasta and East Shasta copper-zinc belts, which extend from Iron Mountain northeastward to Backbone Creek and then east to Ingot, a distance of about 30 miles. The mines included in these belts have been the source of more than 703 million pounds of copper, amounting to about 54 percent of the copper produced in California. The Iron Mountain district, which is the largest and most important district, includes the Balaklala, Keystone, Mammoth, Mountain Copper Company, Shasta King, and Sutro mines, each

of which has a recorded production of more than a million pounds of copper. The Bully Hill district, next in importance, is about 15 miles east of Iron Mountain and includes the Bully Hill-Rising Star group of mines owned by the Glidden Company. This group and the Afterthought mine, at Ingot about eight and a half miles southeast of Bully Hill, also have each been the source of more than a million pounds of copper. No large orebodies have been discovered between these districts. The Greenhorn mine, southwest of French Gulch and nine miles west of the Iron Mountain area, is the only important copper mine developed in Shasta County outside of the two copper-zinc belts.

Copper was first mined in Shasta County in 1862 at Copper City, then known as Williams. In 1863, about 250 tons of ore shipped to Swansea, Wales, for treatment assayed 8 percent copper, $40 in gold, and $20 in silver, but netted only a small profit.

The Iron Mountain property was purchased originally in 1894 by the Mountain Mines, Ltd., an English corporation. In 1896, it was acquired by the Mountain Copper Company, Ltd., which remained active at Iron Mountain until the end of 1962. Their smelter built at Keswick in 1896 was operated until 1907, after which ore was shipped to their new smelter near Martinez. Many improvements in the metallurgy of sulfide ores and in the design and operation of roasting and smelting furnaces were developed by the Mountain Copper Company at Keswick.

Between 1901 and 1908, copper smelters were built and operated at the Afterthought, Balaklala, Bully Hill, and Mammoth mines. An increase in the zinc content of the ores, together with increasing costs of operation, lower prices for copper and silver, and damage suits for smoke nuisance, combined to make copper smelting unprofitable in Shasta County, and all the smelters were idle by 1919. A reverberatory furnace and zinc oxide plant built in 1922 at Bully Hill was operated for about six months.

Production of copper from the complex copper-zinc ores that occur in Shasta County is handicapped in many ways. Marketable concentrates can be produced by selective flotation, but the fine grinding required to effect a separation of the minerals is costly, and much copper and zinc is lost in the process. Zinc concentrates commonly contain one and a half to two percent copper, whereas copper concentrates commonly contain five to ten percent zinc, and neither of the lesser elements are paid for by the smelter. The freight paid in shipping the concentrates to smelters in Montana, Texas, Utah, or Washington is an additional handicap. Recent developments in fluosolid roasting suggest that massive sulfide ores or bulk flotation concentrates can be roasted and then leached, and the copper and zinc recovered electrolytically. The sulfur products recovered in the roasting process have possible uses in the fertilizer, oil refining, paper, and plastic industries.

Except for the copper-zinc ore mined by the Mountain Copper Company, Ltd., at Iron Mountain from 1943 to 1947, and at the Afterthought mine at Ingot between 1948 and 1952, no attempt has been made to mine these complex ores for thirty years or more.

Geology

Copper ore in the West and East Shasta districts consists chiefly of massive sulfide deposits composed principally of pyrite with subordinate but locally important amounts of chalcopyrite, sphalerite, galena, tetrahedrite, silver, and gold; gangue minerals are quartz, calcite, and barite, with gypsum in addition being notable in the East Shasta district and sericite and chlorite in the West Shasta district.

The effective ore controls and modes of occurrence of massive sulfide ore are distinct in the two districts.

In the East Shasta district, the ore consists of isolated lenses or groups of lenses that replace Bully Hill Rhyolite or, to a lesser extent, rocks of the Pit Formation. The orebodies, which generally are tabular and steeply dipping, are localized along shear zones in the Bully Hill Rhyolite or at fault contacts between the Bully Hill and the Pit Formation. The ore itself usually is fine-grained and has a banded texture. An overall assay of the ore produced in this district is as follows: 15 to 20 percent zinc, 3 percent copper, 0 to 2 percent lead, 5 ounces silver, and 0.03 ounce gold (Albers and Robertson, 1961, p. 68).

In the West Shasta district, most orebodies are flat-lying, lenticular masses, many of which have been disrupted to greater or lesser degree by post-mineral faulting. The Iron Mountain orebody, for example, was 4,500 feet long before it was faulted into the discrete masses of ore that subsequently were mined by the Mountain Copper Company. Massive sulfide ore is characterized by the virtual absence of megascopic gangue minerals, with pyrite usually comprising 90 to 95 percent of the rock. In a few areas, other types of ore are present: chalcopyrite in veinlets and disseminated grains sometimes occurs in equal amounts with granular pyrite, set in a siliceous matrix; sulfide ore locally is banded rather than structureless; and zinc-rich (sphalerite-bearing) ore also is present in the district. Massive sulfide orebodies have sharp borders against barren or weakly pyritized rock; because the wallrock tends to slough easily, the usual mining practice is to leave a "screen" of ore in mined-out stopes.

Massive sulfide should not be confused with rock containing masses of disseminated pyrite. This latter type of mineralization consists of 50 to 75 percent pyrite, usually as minute euhedral cubes, in a gangue of secondary quartz and unreplaced rock. The pyrite tends to be coarser grained than in the massive sulfide, and the pyritic mineralization itself does not have sharp contacts with the enclosing wallrock. Except in rare local instances, disseminated pyrite does not grade into massive sulfide. The distinction between these two occurrences of sulfide is of considerable economic importance, because the disseminated variety contains little or no copper and is devoid of zinc, silver, and gold.

The gossan or oxidized "capping" over the two types of sulfide also reflects their essential difference. Massive sulfide gossan is more or less residually enriched in gold and silver whereas that over the disseminated

pyrite contains nothing. Experience in the West Shasta district shows that gossan containing residual gold overlies massive sulfide that invariably contains copper, zinc, and silver. Massive sulfide gossan is characterized by bold outcrops that are resistant to weathering. Hard, dark, reddish-brown limonite with an irregular, cellular texture is the principal constituent, and widely spaced, narrow ribs of silica are a subordinate component.

Ore controls are both stratigraphic and structural. The Balaklala Rhyolite has been separated by Kinkel *et al.* (1956) into an upper unit characterized by coarse phenocrysts of quartz (greater than 4 mm. in size), a middle unit with medium phenocrysts of quartz (1 to 4 mm.), and a lower, non-porphyritic unit. The upper part of the middle unit, which includes more water-laid tuff and volcanic conglomerate than any other part of the Balaklala, contains all the known massive sulfide ore in the district. Mineralization is so well localized by this part of the middle unit that it is almost continuously pyritized throughout the district; orebodies are present within this mineralized zone as discrete, sharp-walled masses.

Structural ore controls are somewhat complex. Steep fracture cleavage has been well developed at the crests and troughs of folds in the lower and middle units of the Balaklala Rhyolite but is quite rare in the upper unit. Bedding-plane foliation, developed when the rocks were folded into a series of gentle flexures, is concentrated in the incompetent pyroclastic beds of the upper part of the middle unit. The intersection of these two structures tended to localize ore on folds, inasmuch as it was only here that steeply dipping fractures were developed under an impervious cover formed by beds with flat foliation.

Pre-mineral faults that may have acted as feeders for rising ore solutions also aided in determining the ultimate distribution of ore. Most orebodies are near, although not necessarily adjacent to, major faults or shear zones that generally trend N. 70° E.

Guides for Prospecting

Both Kinkel *et al.* (1956) and Albers and Robertson (1961) have indicated areas favorable for further exploration for massive sulfide ore, in the West and East Shasta districts, respectively. Kinkel *et al.* emphasize the importance of stratigraphic ore control and point out (1956, p. 101), "No lateral controls for ore can be used with certainty to eliminate areas [from exploration], where the middle unit of the Balaklala is known to be present." Areas within outcrops of the middle unit that are less favorable than others for the occurrence of ore, but that are not necessarily barren, include those where the rocks are closely folded or where the middle unit is thin, and areas on the flanks of folds. Kinkel *et al.* (1956, plate 4) have precisely delineated those areas they consider to be most favorable for prospecting; these areas, which contain all or most of the middle unit and are hydrothermally altered and mineralized, are as follows:

1) An area north and east of the Golinsky mine, in Secs. 28 and 33, T. 34 N., R. 5 W.
2) An area northwest of the Sutro mine, in Secs. 19 and 30, T. 34 N., R. 5 W. (proj.).
3) A half mile northwest and 1¼ miles southwest of the Mammoth mine, in Secs. 31 and 32, T. 34 N., R. 5 W. (proj.).
4) A wide, elongate area north of the Shasta King mine, in Secs. 1 and 12, T. 33 N., R. 6 W.
5) A large area bounded by the Stowell, Balaklala, Balaklala angle station, Spread Eagle, and King Copper properties, in Secs. 12, 13, 14, 23, and 24, T. 33 N., R. 6 W.
6) A narrow, elongate zone south of the Early Bird mine, in Sec. 11, T. 33 N., R. 6 W.
7) A wide, elongate area beginning 0.4 mile southwest of the Stowell mine and extending southward for a mile, in Secs. 22 and 23, T. 33 N., R. 6 W. (proj.).
8) A short, narrow zone northeast of the Lone Star mine, in Sec. 27, T. 33 N., R. 6 W. (proj.).
9) A narrow, elongate, northeast-trending zone about 0.3 mile southeast of Sugarloaf Mountain in Sec. 26, T. 33 N., R. 6 W. (proj.).
10) A triangular-shaped area bounded on the west by a north-south line through Iron Mountain, with its apex almost at Boulder Creek, in Secs. 27 (proj.), 34, and 35, T. 33 N., R. 6 W.
11) The region southeast of Mule Mountain. ("Reconnaissance in the unmapped area southeast of Mule Mountain suggests that prospecting for base-metal orebodies in the hydrothermally altered rhyolite in this area is warranted": Kinkel *et al.*, 1956, p. 101, ff.)

Albers and Robertson (1961, p. 79) found in the East Shasta district that "silicified rock containing in relative abundance one or more of a group of minerals that includes barite, anhydrite, calcite, hydrous mica or sericite, and pyrite in close proximity to a shear zone or fault is regarded as a favorable indication of sulfide mineralization." Favorable areas for prospecting for massive sulfide ore are defined on the basis of 1) their proximity to shear zones or faults in the Bully Hill Rhyolite or in the Pit Formation close to its contact with the Bully Hill, and 2) the presence of strongly silicified rock that in places contains disseminated base-metal sulfides, barite, disseminated pyrite, or limonite. These areas, indicated in detail by Albers and Robertson (1961, plate 3), are as follows:

1) An elongate, northeast-trending zone up to half a mile wide that extends from a mile southwest of the Copper City (Baxter-Winthrop) mine to a mile northeast of Bully Hill, in Secs. 15, 16, 20, 21, and 29, T. 34 N., R. 3 W.
2) A northwest-trending area half a mile long at the Shasta May Blossom property, in Sec. 14, T. 34 N., R. 3 W.
3) An area just north of Brushy Canyon, in Sec. 34, T. 34 N., R. 3 W. (proj.).
4) A northwest-trending area 1½ miles northwest of Ingot, in Secs. 4 and 9, T. 33 N., R. 2 W.
5) A narrow, northwest-trending zone that extends from Sugarloaf southeast to (and beyond?) the limit of the area mapped, at Norton Gulch; Secs. 3, 4, 10, and 11, T. 33 N., R. 2 W.

With respect to these areas, Albers and Robertson (1961, p. 80) point out that ". . . any serious prospecting program should begin with the detailed mapping of shear zones, faults, and alteration features. This should be followed by a geophysical and possibly geochemical survey of the most promising localities in order to define as closely as possible potential targets for diamond-drill exploration."

Afterthought mine. Location: Secs. 10, 11, and 15, T. 33 N., R. 2 W., M.D., 24 miles east of Redding adjacent to Highway 299. Ownership: About 1200 acres of patented land are owned by Coronado Copper and Zinc Company, Pacific Mutual Building, 523 West 6th Street, Los Angeles 14, California.

The Afterthought mine is situated on the contact between Bully Hill Rhyolite and the Pit Formation, which here strikes northwest and dips northeast at moderately steep angles. The contact is disrupted to a bench- or step-like form by a series of steeply dipping strike faults. Rocks in the mine area have been hydrothermally altered and generally contain conspicuous quantities of albite, silica, hydrous mica, calcite, and pyrite.

Sulfide orebodies replace sheared, altered, Bully Hill Rhyolite and metasedimentary rocks of the Pit Formation; they range up to 400 feet in maximum dimension and 50,000 tons in mass. About 16 orebodies, either massive sulfide or else banded, lower-grade material in partially unreplaced rock, have been mined; they were lenslike, tabular to cigar-shaped masses. Most of them had a horizontal rake, striked northwest, and dipped vertically or steeply southwest. The distribution of orebodies is controlled by the premineral strike faults, the Main fault (the youngest and most prominent fault in the mine, also premineral), and drag folds in metasedimentary rock.

The ore itself is commonly banded and consists of a fine-grained mixture of sphalerite, pyrite, chalcopyrite, galena, tetrahedrite, bornite, luzonite, and gangue minerals (calcite, quartz, barite). According to the Coronado Copper and Zinc Company (Albers and Robertson, 1961, p. 81), 166,424 tons of ore extracted from the Afterthought mine during 81½ months of operation between 1905 and 1952 contained 3.23 percent copper, 16.15 percent zinc, 2.17 percent lead, 5.55 ounces per ton silver, and 0.03 ounce per ton gold.

The Afterthought mine has 17,200 feet of drifts, crosscuts, and stopes, and 2,200 feet of shafts, raises, and winzes. These are distributed over 10 levels with a vertical extent of 729 feet. The main haulage (or 400) level extends 2,910 feet eastward from its portal on Little Cow Creek. At 1,450 feet from the portal, Shaft No. 1 rises 329 feet to the surface. Two vertical underground shafts, 300 and 400 feet deep, are situated 200 to 350 feet east of Shaft No. 1 and connect the 400 level with the lower workings.

This mine has a history dating from 1862 when seven claims of the Copper Hill group were located and worked for gold and silver. In 1873, C. M. Peck purchased the property for $6,000, named it the Peck mine, and mined copper ore that was shipped to Swansea, Wales, for processing. In 1875 he built a small reverberatory furnace to reduce the sulfide ore; it failed to perform satisfactorily, as did also a water-jacketed furnace built soon afterward. Subsequently the property was acquired by a group of Red Bluff men, and a 25-ton, water-jacketed blast furnace was built; it too failed.

In 1896, 200 tons of ore were smelted; according to the mine superintendent, it contained 37 percent copper, 45 ounces per ton in silver, and $7 per ton in gold (Aubury, 1902, p. 66).

The Great Western Gold Company acquired the Afterthought mine in 1903, built a 250-ton water-jacketed blast furnace, and for the first time successfully reduced ore in 1905. This operation lasted until 1908 and reportedly returned $350,000 annually (Brown, 1916, p. 761).

In 1909 the Afterthought Copper Company acquired the property. They completed construction of an oil-flotation mill and reverberatory furnace, each of 300 tons capacity, in 1919. Operation of this equipment began in July 1919 and lasted only eight months. Late in 1923, the company lost the property by foreclosure.

In February 1925, The Glidden Paint Company, under the name California Zinc Company, began mining zinc ore under lease. The ore was moved by an 8½-mile aerial tram to the Bully Hill mill. A drop in the price of copper and zinc in 1927 caused the operation to close down.

The property remained inactive until 1945–1946, when the Coronado Copper and Zinc Company began exploratory drilling. In February 1947, the Afterthought ground and many other claims were assigned by quitclaim deed to the Afterthought Zinc Mining Company. A few months later, this company sold all of its property in Shasta County—including the Afterthought mine—to the Coronado Copper and Zinc Company for $110,000. The Coronado interests built a 100-ton flotation mill and began mining in October 1948. Crude sulfide ore was ground to 94 percent minus-200 mesh, and two concentrates were made by selective flotation. The copper-lead concentrate was shipped to Tooele, Utah, for smelting, and that of zinc was sent to Great Falls, Montana. Between July 1949 and July 1950, a drop in the price of the base metals kept the mine idle. It was reopened and operated continuously until August 1952, when depletion of ore reserves closed it once again. It has been idle since.

Photo 4. Mine shops and one-hundred-ton flotation mill of the Afterthought mine, November 1948. At this time it was operated by the Coronado Copper and Zinc Company.

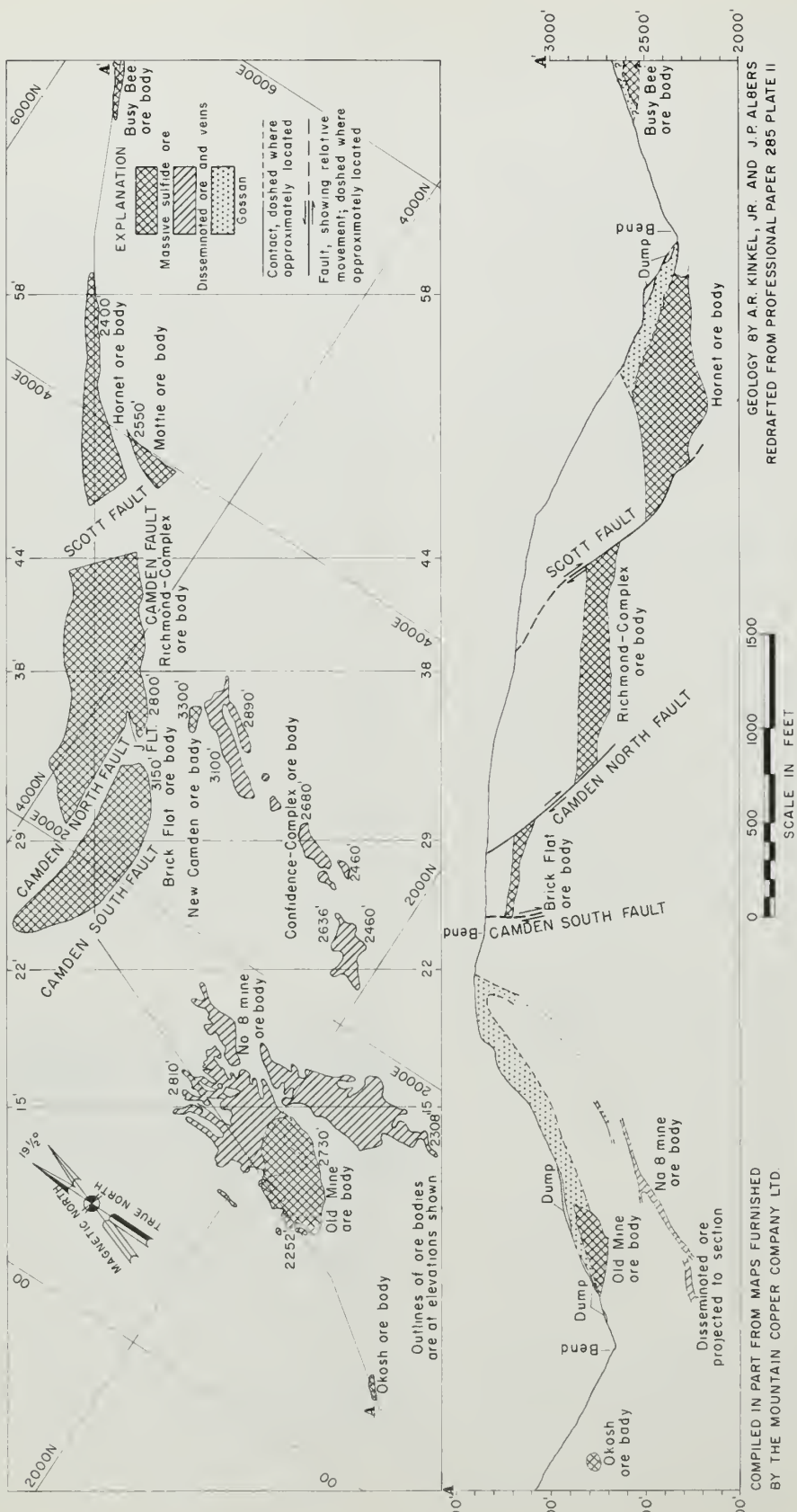


Figure 3. Cross-section through Afterthaught mine. The drawing shows the relationship between ore bodies and major structural features. *Adapted from Albers, 1953, plate 5, section B-B'.*

Balaklala (Windy Camp) mine. Location: Sec. 7, T. 33 N., R. 5 W., M.D., and Secs. 10, 11, 12, 13, and 14, T. 33 N., R. 6 W., M.D., about four miles west of Shasta Dam. Ownership: Shasta Minerals and Chemical Company, 826 South Main Street, Salt Lake City, Utah.

The principal rock types exposed at this mine are the upper and middle units of the Balaklala Rhyolite. The upper unit consists of massive, hard, light gray rock with conspicuous coarse phenocrysts of quartz. Beneath this is a zone of shaly tuff and fine pyroclastic debris the different varieties of which have little lateral continuity; as a whole, however, the zone is continuous and is underlain by flows of medium-phenocryst and non-porphyritic rhyolites, belonging to the middle unit. The rocks of both units have been gently folded and are cut by many faults with small offsets. The northwest-trending Balaklala fault, the most prominent in the area, has a vertical displacement of 220 feet with the north side down and can be traced one and three-quarters miles west of the mine.

Prior to being offset by the Balaklala fault, the principal orebodies (Windy Camp and Weil) were part of an elongate, northeast-trending, basin-shaped lens of massive ore that was 1,400 feet long, almost 500 feet wide, and up to 75 feet thick. Several smaller orebodies, not part of this larger mass, also are present; they, too, consist of massive sulfide, but their content of copper and zinc varies considerably.

Ore consists of hard, fine-grained pyrite that contains chalcopyrite, sphalerite, gold, and silver. The grade of ore tends to be uniform, but locally ore of much richer grade than the average was encountered. Kinkel *et al.* (1956, p. 103) estimate that the mine yielded 1,200,000 tons of ore that averaged 2.8 percent copper, 1.3(?) percent zinc, 1.0 ounce per ton silver, and 0.028 ounce per ton gold. The High Grade and Bull orebodies, however, contained 12 and 10 percent copper, respectively; gold content here also was higher than average, although zinc remained constant. In addition, ore in the lower 10 feet of the large open cut in the Windy Camp orebody was of higher grade, averaging 5 percent copper, 1.0 ounce per ton silver, and 0.036 ounce per ton gold.

Workings of the Balaklala mine include 20 adits and almost as many stopes. The main haulage adit, the Weil, is 1,500 feet long and has about 4,500 feet of subsidiary drifts, stopes, and raises; Tunnel 8, driven 800 feet southeast from the large open cut, similarly has many hundreds of feet of subsidiary workings.

The Balaklala mine was first worked during the 1890's or possibly somewhat earlier. By early 1902, about 3,500 feet of drifts and crosscuts had been driven, and the property had been thoroughly drilled. It was active from 1906 to 1911 and 1914 to May 1919. A smelter with a daily capacity of 1,000 tons of ore was built at Coram (near Shasta Dam) in 1906, and ore was brought to it by an aerial tramway 16,500 feet long. The smelter closed down in 1911, because it became a smoke nuisance, and was dismantled in 1920. During the later period of operation, ores were hauled to the Mammoth smelter at Kennett.

During 1924–1925 the Mammoth Copper Company (U.S. Smelting, Refining and Mining Company) mined ore under lease. The Mason Valley Mining Company mined pillars of ore left from previous operations under lease from March 1926 to May 1928. The mine has been idle since then except during 1948, when part of Tunnel 8 was reopened, and 1956, when a Defense Minerals Exploration Administration loan of $54,910 was granted to the Shasta-Phelps Dodge Joint Venture (see Walker Corporation group in tabulated list under copper), which then diamond-drilled the property. The mine plant, tram terminal, and ore bunkers were destroyed by fires in 1924 and 1931 and the last remains of the plant were salvaged for scrap metal after World War II.

Bully Hill-Rising Star mines. Location: Secs. 15, 16, 21, 22, and 28, T. 34 N., R. 3 W., M.D., about 18 miles northeast of Redding, California. Ownership: 526 acres are owned by The Glidden Company, Cleveland, Ohio.

The main shaft of the Bully Hill mine is about 1,600 feet northeast of that of the Rising Star mine, and the workings of the two approach within 500 feet of each other. The area embracing both mines is underlain chiefly by flows, breccia, and tuff of quartz keratophyre (sodic trachyte) and metadacite, belonging to the Bully Hill Rhyolite. A few hundred feet east of the shafts are exposures of the Pit Formation, consisting of mudstone, siltstone, and metamorphosed tuffs of andesitic, dacitic, and quartz-keratophyric composition. South and southeast of the Rising Star shaft, the contact between the two formations trends northeast, whereas east of the Bully Hill shaft it trends north-northeast to north. Beginning 500 feet south of the Bully Hill shaft, a fine-grained intrusive mass of metadiabase is discontinuously exposed for several hundred feet to the north; it intrudes chiefly the Bully Hill Rhyolite but also cuts the Pit Formation.

A broad, southeast-plunging anticline underlies much of the area, with its axis passing through the Rising Star mine. Some of the component beds, especially north of the Bully Hill shaft, are overturned and dip moderately to steeply westward; with increasing depth, however, they become vertical and then dip steeply eastward. Drag folds superimposed on this structure are common in the sedimentary rocks.

Steeply dipping shear zones up to 50 feet wide but without significant displacement are prominent in the area. The Bully Hill shear zone more or less parallels the contact between the Bully Hill and Pit rocks, but except for a small portion in the southern part of the mine area, where it separates the two formations, it lies within the Bully Hill Rhyolite several hundred feet west of the contact. Three other shear zones, the East, Middle, and Rising Star, strike from north-northwest to northwest, and appear to emanate from a small area about 500 feet southeast of the Rising Star shaft. There are many faults in the mine area, the most important of which is the Contact fault. Northeast of the Bully Hill shaft, this fault separates the Pit Formation and Bully Hill Rhyolite, but to the south it passes into the Bully Hill Rhyolite and finally is cut

off by the Bully Hill shear zone about 400 feet south of the Bully Hill shaft. It appears to have had a reverse dip-slip movement of 500 feet.

All the rocks of igneous origin in the mine area have been thoroughly altered by solutions that introduced albite, silica, chlorite, hydrous mica, sulfate minerals, and pyrite. The spatial distribution of intensely silicified rocks, pyrite, limonite, sulfate minerals (barite, gypsum, anhydrite), and sulfide orebodies suggests that all are genetically related.

Orebodies are lenticular masses ranging up to 300 feet in length and height and to 40 feet in thickness. Steeply dipping lenses in the Bully Hill mine are distributed chiefly along the Bully Hill shear zone, in and near porphyritic quartz keratophyre and in metadiabase. In the Rising Star mine, ore follows the three major shear zones within the porphyritic quartz keratophyre in that area, but also extends along subsidiary faults away from the shear zones.

The ore is a dense, fine-grained mixture of pyrite, sphalerite, chalcopyrite, galena, tetrahedrite-tennantite, and bornite; secondary minerals are confined chiefly to the upper 300 feet of the mines, and consist of native copper and oxides, carbonates, and sulfides of copper. Locally, sphalerite-rich ore contains as much as 20 percent zinc, whereas elsewhere pyrite or chalcopyrite is dominant. Silver occurs principally in galena and tetrahedrite-tennantite, whereas minor amounts of gold are distributed throughout the massive sulfide ore. Both precious metals occur in the free state in the oxidized ore. Anhydrite and gypsum are prominent gangue minerals in the Rising Star mine but are of only local importance in the Bully Hill mine.

Albers and Robertson (1961, p. 90) have presented data indicating that the Bully Hill-Rising Star mines yielded almost 580,000 tons of ore between 1900 and 1950, containing about 48.8 million pounds of copper, 25.1 million pounds of zinc, 38,000 ounces of gold, and 2.2 million ounces of silver.

Workings of the Bully Hill mine trend northward and indicate development along a steeply east-dipping plane; the positions of numerous stopes suggest that the mineralized zone raked steeply northward. The Bully Hill shaft is about 800 feet deep, but rises to only the 300 adit level, which provided access from the northeast. The longitudinal projection of the 870 level is more than 1,800 feet long. In all, six adits and thousands of feet of drifts, raises, winzes, and stopes on 11 main levels have been driven to develop the mine.

At the Rising Star mine, the workings occupy an oval-shaped area in horizontal projection, with the long axis having a north-northwest trend. In contrast to those at the Bully Hill mine, the workings on most individual levels have explored or developed a zone 200 to 300 feet wide. Several adits and shafts, and several thousand feet of workings involving seven levels and extending to a depth of about 750 feet, are present.

Mining of oxidized rock and gossan for their precious metal content began in the Bully Hill area in the early or middle 1860's. Most operations of this type were small, but in 1877 the Extra Mining Company built a mill at Copper City and reportedly extracted $640,000 in gold and silver from surface ores, during a few succeeding years (Albers and Robertson, 1961, p. 88). Activity dwindled after sulfide ore was reached, because its precious metals could not be recovered by a free-milling process.

In 1899, J. R. De Lamar purchased 18 claims for $225,000 (Aubury, 1902, p. 75) and began mining the high-grade, secondarily enriched copper zone beneath the gossan; two years later the Bully Hill Copper Mining and Smelting Company was formed, with De Lamar as president.

A copper smelter began operation in May 1901. Ore was roasted in stalls, then charged to a furnace together with uncalcined ore, coke, and limestone and magnetite from along the McCloud River. Furnace matte then was reduced in converters to blister copper. The smelter capacity was 150 tons daily, but it was enlarged in 1906–1907 to 400 tons.

Mining until 1910 was concentrated in the zones of oxidation and enrichment, so that relatively high yields of copper, gold, and silver were obtained. In 1902, mining to supplement the smelter feed began at the Rising Star, but increasing zinc and decreasing copper content created difficulties in treating the ore. The mine and smelter closed in 1910 because of this, and probably also because of litigation over the smelter fumes.

In 1915, a brief attempt was made to separate zinc by electrolysis of zinc sulfate but was unsuccessful.

The Bully Hill Mines Company, Inc., acquired the properties early in 1917 and reactivated the Rising Star mine. High-grade zinc ore was encountered and a flotation mill was built and operated briefly in 1918 to handle it.

In 1920, the Shasta Zinc and Copper Company took over the property. An experimental plant, in which zinc oxide was produced by a fuming process, was completed in 1921; 9,000 tons of ore treated in 1922 averaged 20.92 percent zinc.

The Glidden Company acquired the Bully Hill, Rising Star, and other properties in August 1924, under the name of California Zinc Company. The fuming plant was used until late 1925, when concentration by oil flotation was substituted; the bulk concentrate, containing 43 to 49 percent zinc, 3.7 to 4.1 percent copper, 1.3 to 1.7 percent lead, and silver and gold, was shipped to Belgium for smelting. Activity ceased in 1927.

During 1950–1951, lessees cleaned out and shipped the slag from the old smelter furnace, and considerable amounts of copper, zinc, gold, and silver were recovered.

In December 1951, a Defense Minerals Exploration Administration loan of $147,150 to The Glidden Company was approved for a diamond-drilling exploration program. E. J. Longyear Company put down five holes totaling about 5,000 feet in the Bully Hill shear zone, searching for the northern extension of the mineralized zone. Some ore was found about 800 feet north of the old workings, but drilling was very difficult and core recovery was poor. Approval was obtained to reopen the mine and continue the exploration underground. The 300-level adit was retimbered 970 feet to the Bully Hill shaft, and the old workings

Photo 5. Compressor house and portal of adit no. 3, Bully Hill copper mine, June 1954.

were unwatered to the 870 level. Mine crews reopened the old levels and extended them to points from which diamond drilling could be done advantageously. About 6,000 feet of hole were drilled. New orebodies were discovered in the shear zone between the Bully Hill Rhyolite and metadiabase intrusive. Assays indicated an average grade of about 1.5 percent copper, 8 percent zinc, 4 ounces of silver, and 0.11 ounce of gold.

Exploration work was stopped June 1, 1956, as the price of copper began a severe drop, and the mine was allowed to fill with water. All buildings, machinery, and equipment have since been removed.

Early Bird mine. Location: Secs. 10 and 11, T. 33 N., R. 6 W., M.D., about 5½ miles west of Shasta Dam. Ownership: Shasta Minerals and Chemical Company, 826 South Main Street, Salt Lake City, Utah.

Exposures are poor in the vicinity of the Early Bird mine, but the ore is known to occur in light-gray, medium-porphyritic metarhyolite of the middle unit of the Balaklala Rhyolite. Immediately overlying this is a flow of non-porphyritic rhyolite, which, on a ridge 300 feet above the mine, is overlain in turn by the Kennett Formation.

The orebody is a flat-lying, elongate, north-northeast trending mass of sulfide up to 85 feet wide and averaging 15 to 20 feet in thickness. It has been mined along a strike length of 460 feet; ore remained in the stope faces when mining ceased, and unexplored ground lies to the north and south. Three closely spaced, northeast-dipping faults cut the orebody close to the center of its developed length. The principal fault has a vertical offset of 34 feet.

Ore consists of dense, massive pyrite cut by veinlets of chalcopyrite, sphalerite, and quartz. High-grade ore amounting to 5,116 tons contained 10.27 percent copper, 0.41 ounce per ton silver, and 0.015 ounce per ton gold. About 35,000 tons of "ordinary" ore contained 3.40 percent copper, 2.00 ounces per ton silver, and 0.034 ounce per ton gold. Four drill holes cut ore (most of which subsequently was mined) averaging 3.01 percent copper, 1.53 ounces per ton silver, and 0.03 ounce per ton gold. (Kinkel *et al.*, 1956, p. 112.)

Workings consist of a crosscut adit 350 feet long and 460 feet of drifts under the orebody, with raises into it. A short adit southwest of and a hundred feet above the main adit portal resulted from early work on the property.

The upper adit probably was driven around 1908, but ore was not found until the property was drilled in 1918. Four years later, it was leased to United States Smelting Refining and Mining Company, and a few thousand tons of high-grade ore were mined between then and 1925. The Mason Valley Mines Company leased the mine during 1926–1928 and is responsible for most of the stoping that was done. The property has been idle since then, except for a brief interval in 1948 when the old workings were opened up. Some drilling has been done here in recent years (see Walker Corporation group in copper section of tabulated list).

Greenhorn (Atascadero, Warren Brothers, Willow Creek) mine. Location: Secs. 5 and 6, T. 32 N., R. 7 W., and Sec. 31, T. 31 N., R. 7 W., M.D., about 23 miles northwest of Redding. Ownership: Greenhorn Mining Company, c/o Wayne Atwood, P. O. Box 188, Springfield, Oregon, which owns 12 patented claims.

Foliated, bedded rocks of the Balaklala Rhyolite in the vicinity of the mine are overlain by phyllitic slate of the Bragdon Formation; both units have been slightly metamorphosed by the Shasta Bally batholith. The Balaklala-Bragdon contact trends N. 60° W. and dips 30° to 50° northeast in the mine; both folia and shears in the Balaklala Rhyolite have similar attitudes. Several steep normal faults disrupt the rocks; they strike northward and dip generally eastward. The largest fault has a dip-slip displacement of 50 feet, with the east side downthrown.

Sulfide orebodies are tabular replacement masses, the attitudes of which approximately parallel those of the Balaklala folia and shears. They are 25 to 30 feet thick, but their lateral extent is uncertain. They occur in a zone about a hundred feet below the Bragdon slates, and are marked at the surface by a prominent gossan. Massive sulfide ore grades laterally into less pyritized rock.

Sulfide ore consists of about 90 percent pyrite, subordinate chalcopyrite and quartz, and minor chalcocite. The average copper content is a little more than 2 percent (Albers, 1965). According to Averill (1939, p. 126–127), one lens contained 80,000 tons of ore averaging 4.3 percent copper, and another contained 1 to 2 percent copper and $1.50 per ton in gold and silver. Grant (1932) reported that the primary ore contained some pyrrhotite without arsenic or selenium; in addition, he noted, the ore averaged 0.5 percent zinc and a trace of lead.

Secondary ore consists of native copper, cuprite, malachite, chrysocolla, bornite, chalcocite, and scattered, residual primary minerals. It occurs as an irregularly shaped wedge between the gossan and the primary sulfide ore.

Photo 6. Copper-cement precipitation boxes at the Greenhorn copper mine, 1956. View narthwest.

The gossan consists of typical reddish-brown, hard, siliceous, locally porous limonite that is residually enriched in gold and, in its lower parts, in silver.

According to Wilbur Grant (1932), the Greenhorn mine was discovered around 1894, and about 1900 was optioned to De Lamar (see Bully Hill-Rising Star mine), who drove 3,000 feet of workings. Mr. Ditmar obtained an option on it under the name of Greenhorn Mountain Copper Company in 1911, and during the next two and a half years 1,700 tons of high-grade ore averaging 10 percent copper were shipped to the Mammoth smelter at Kennett. The smelter closed down in 1919 and there was no further production from the Greenhorn until the price of copper rose to 18 cents per pound in 1928.

Between December 1928 and May 1930, 32 shipments of ore were made, totaling 1,783 tons and having a gross value then of $50,000. The copper content ranged from 2.12 to 34.23 percent and averaged 7 to 10 percent; silver ranged from 0 to 0.53 ounce per ton and averaged about 0.10 ounce; gold ranged from 0 to 2.28 ounces per ton and averaged 0.80 ounce (Grant, 1932). This ore was mined from an enriched zone and consisted of chalcocite and cuprite with some azurite, malachite, and native copper.

During these operations, the mine was developed by six adits spaced at irregular intervals between elevations of 1,833 and 2,269 feet. An adit at 1,867 feet was driven eastward for about 1,200 feet; a 90-foot raise was driven above this adit but failed to cut an orebody. In all, the orebodies were explored and developed by about 12,000 feet of drifts, raises, and stopes. The ore was mined by room and pillar stoping with occasional timber support.

The mine lay idle from 1930 to 1936, when the Greenhorn Mining Company obtained a $20,000 loan from the Reconstruction Finance Corporation to develop the gossan overlying the sulfide orebody. An additional 2,000 feet of workings were driven during 1938–1939. Sufficient gold and silver were found in the gossan to induce Willow Creek Mines, Inc., to lease the property in 1939 and build a 300-ton cyanide leaching plant. Overburden six to 20 feet thick was stripped from the gossan with a bulldozer and carryall; ore was blasted by shallow holes and hauled a short distance to the mill, where it was crushed to minus-6 mesh and gold and silver were recovered by the cyanide process in a seven-day leaching cycle. The company mined and milled 75,000 tons of ore that yielded $218,000 in gold and silver (Albers, 1965).

The operation was marginal, however, and when heavy rains washed out the tailings dam in March 1941 and damage suits were filed, the operation was shut down. All equipment and buildings were removed from the property.

The mine remained idle until it was purchased by the present owners in 1956. In April of that year, about 300 feet of four- by four-foot precipitation boxes were built and filled with scrap iron, and mine water was drained through plastic pipes to fill the boxes. The amount of copper precipitated was negligible. Crews of men were put to work reopening No. 1 and No. 2 adits, and the Miami Copper Company was induced to conduct an exploration program. During

Photo 7. Diamand drilling at the Greenhorn copper mine, 1957.

the first half of 1957, the gossan area was mapped and a few diamond drill holes were put down. The results from the exploration program were discouraging and the program was discontinued in a few months. The property has been idle since.

Iron Mountain (Complex, Hornet, Lost Confidence, Mattie, No. 8, Old Mine, Richmond) mine. Location: Sec. 6, T. 33 N., R. 5 W., and Secs. 22, 26, 27, 34, and 35, T. 33 N., R. 6 W., M.D., about nine miles airline or 15½ miles by winding mountain road northwest of Redding. Ownership: The Mountain Copper Company of California, 100 Mococo Road, Martinez, California.

The principal rock types exposed at Iron Mountain are chloritized mafic flows and minor pyroclastic debris of the Copley Greenstone, and sheared and folded lenticular flows, pyroclastic rocks, and intrusive masses of Balaklala Rhyolite. Albite granite related to the Mule Mountain stock is exposed east of the mine area. All three units of the Balakala are present here, but it is difficult to distinguish between the middle and lower units, and much of the upper unit has been eroded. A tuffaceous zone transitional between the middle and upper units remains, however, affording an important guide to the distribution of ore. The rocks have been folded into a series of northeast-trending anticlines and synclines, and are cut by a fault zone that trends to the east in the western part of the property and to the northeast elsewhere. Individual components of the zone, which includes the Camden North, Camden South, J. Scott, and Sugarloaf faults, have strikes ranging from northwest to northeast.

The Camden and Sugarloaf faults are both pre- and post-mineral and are thought to have been channels along which ascended the ore solutions that formed the Brick Flat, Richmond-Complex, Hornet, and Busy Bee orebodies. The Old Mine and No. 8 orebodies dip away from these faults and thus probably had a different source. Replacement of rock by ore has favored the massive, medium-phenocryst (2 to 4 mm.) metarhyolite, and has not occurred significantly in flow-banded or massive, nonporphyritic rhyolite or rhyolitic volcanic breccia of the middle unit. Pre-existing, impervious, gouge-filled faults also appear to have played a role in determining the distribution of ore.

Ore consists of a) massive bodies of pyrite with subordinate chalcopyrite and sphalerite, and b) zones of disseminated chalcopyrite and quartz-chalcopyrite veins in schistose rock. The Hornet, Richmond-Complex, and Brick Flat orebodies were a continuous sheet of massive sulfide, wedge-shaped in both plan and section, before it was disrupted by the Scott and Camden faults. The Mattie, New Camden, and Old Mine orebodies to the south and southeast also are massive sulfide, as is the Busy Bee to the north. The shapes of these masses vary somewhat, as is apparent in the accompanying map of the orebodies. Not shown in this illustration are the cigar-shaped, flat-lying Mattie deposit, and the synclinal forms of the Richmond-Complex and Brick Flat orebodies.

Massive ore contains pyrite, chalcopyrite, sphalerite, unrecoverable minor amounts of gold and silver, and almost no gangue. Disseminated ore, on the other hand, contains only very minor amounts of sphalerite and precious metals and consists of approximately equal amounts of pyrite and chalcopyrite in sericitic and siliceous rock. Chalcopyrite and sphalerite are concentrated locally along the edges and bottoms of massive sulfide, and have been mined for their base metal content.

According to Kinkel *et al.* (1956, p. 118) and data from Company records in 1965, during about 77 years of operation the Mountain Copper Company mined 2,638,000 tons of gossan containing .073 ounce gold and 8.3 ounces silver per ton; 1,608,000 tons of ore from the Old Mine orebody, containing 7.50 percent copper and 1.00 ounce silver and 0.04 ounce gold per ton; 380,000 tons of copper-zinc ore containing 3.50 percent zinc, 2.00 percent copper, and 1.00 ounce silver and 0.02 ounce gold per ton; and 820,000 tons of disseminated ore containing 3.50 percent copper and 0.04 ounce silver and 0.001 ounce gold per ton. From 1907 to 1962, 5,227,000 tons of pyrite were mined for sulfur. The ore averaged 48-50 percent sulfur and 42-43 percent iron, and contained minor amounts of gold and silver that were not recoverable. Total magnetite mined during 1959 to 1962 was 55,000 tons averaging 60 percent iron.

The enormous gossan at Iron Mountain was discovered in the early 1860's, when William Magee and Charles Camden located it as an iron deposit of some possible future interest. In 1879, James Sallee assayed the gossan and discovered that it contained significant quantities of gold and silver. There followed an interval during which small-scale mining extracted some of the precious metals. In 1884, a Honolulu company bonded the property and built a 20-stamp mill, but then returned the property and its new equipment to the original owners, who continued to operate it for the next decade. About 38,000 tons of gossan were mined between 1889 and 1893.

British interests, organized under the name of Mountain Mines, Ltd., acquired the property late in 1894 or early the following year. Assets of this firm passed to the Mountain Copper Company, Ltd., in 1896. A year later, this company began mining the higher-grade ores for their copper content. During 1897, about 165,000 tons of ore averaging 8.56 percent copper were mined; the following year, 221,895 tons of mined ore averaged 8.42 percent copper. A smelter built in 1896 at Keswick was operated until 1906 and then moved to Martinez. Ore intended for the Keswick smelter was first "heap-roasted," or burned in open air, to reduce the sulfur content. This burning was first done in kilns, then later in open air; at one time, as much as 350,000 tons of ore were burning simultaneously.

Mining of massive sulfide ore for its sulfur content began late in 1907 and is discussed in this report under pyrite. That same year, when it appeared that the high-grade copper ore from the 'Old Mine' was near depletion, diamond drilling revealed the existence of a large mass of siliceous, disseminated copper ore below the 'Old Mine'. This orebody, the No. 8, was devel-

oped by an adit, a three-compartment shaft, and three lower levels. Later, similar ore was discovered at a higher elevation to the east and named the Complex orebody.

The "Minnesota" mill, the first in California to use flotation, was completed in 1915. The ore was crushed to minus-¾ inch at the portal of No. 8, then was moved by rail to the mill proper, where it passed through two sets of 16- by 36-inch rolls. The undersize from a trommel screen having openings 12- by 16-millimeters was treated in a Hancock jig from which a hutch product assaying 7 to 8 percent copper was taken. The tailings from the jig were ground in pebble mills to a minus-60-mesh product which was dewatered and sent to a 10-cell flotation machine. The flotation concentrate assayed 12 to 18 percent copper and the tailings 0.15 to 0.25 percent copper. The Hancock jigs were taken out in 1917, and the rolls and trommels were replaced with ball mills and classifiers. Additional flotation cells were added to convert the mill into an all-flotation plant having a capacity of 500 to 600 tons per day. The mill was closed down in March 1919 because of the low price of copper.

In 1928, the mill was disassembled and moved to a position near the No. 8 portal, inasmuch as the railway formerly used to haul ore to the mill no longer existed. Its installation was completed in April 1929, after which it operated for a year before a sudden drop in the price of copper closed it once again.

Later that year, after considerable study, a 250-ton cyanidation plant was completed and mining of the large gossan at Iron Mountain was started, using open-pit methods. During the next 13 years, approximately 2.6 million tons of gossan were mined. The daily capacity of the cyanide plant was raised to 500 tons and finally, in 1932, to 600 tons.

The Mattie orebody and the Richmond Extension orebody were explored from the Richmond adit (driven in 1919–20) and by diamond drilling during 1939–1942. This work revealed the existence of a considerable body of ore containing 2.25 percent copper and 3.5 to 4 percent zinc. The premium prices offered for these metals under the provisions of the War Production Board's premium price plan in 1942 prompted the building of a selected flotation plant of 350 tons daily capacity at the portal of the Richmond adit.

The Mattie orebody was mined from sub-level stopes using diamond-drill blast holes. The ore was blasted down to scram drifts and pulled to ore passes with electric-powered scrapers. Trains of ore cars were loaded from chutes on the haulage level and pulled by an electric trolly locomotive to the mill ore bin. Mining of the Richmond Extension orebody was done at the same time by undercutting and, later, by underhand stoping, and by a long-wall room and pillar system.

At the mill it was necessary to crush and grind the ore until 95 percent was minus-200 mesh and 80 percent minus-325 mesh in order to effect a separation of the copper and zinc minerals. Lime was added to the ball mill along with zinc sulfate and sodium cyanide to depress the zinc and iron sulfides in the copper flotation circuit. The copper concentrates assayed about 13.7 percent copper. Tailings from the copper cells were treated with copper sulfate, lime, and flotation reagents and sent to the flotation cells in the zinc circuit. A minimum of 47 percent zinc was required in the concentrate by the smelter; in June 1944, a concentrate containing 54.4 percent zinc was being shipped to the smelter at Great Falls, Montana. It was found that delay of more than a week between blasting and milling the ore would materially decrease the metal recovery during flotation. Mining and milling of zinc and copper ores were suspended June 30, 1947, and the milling plant has since been dismantled.

In 1960, the company attempted a pyrite-calcine treating system near its chemical works in Martinez, to permit the recovery of copper-zinc, gold, and silver from the enormous tonnage of calcines left over from the normal processing of pyrite for sulfuric acid. This plant never was put into operation.

Photo 8. Cement-copper precipitotion tonks of Mountoin Copper Compony ot Iron Mountoin, 1962. Surge tonks in foreground assure steody flow of mine woter. Scrap metal and copper cement are moved by crane.

From 1951 to date, cement copper was recovered from mineralized water of the Richmond and Hornet mines by passing it through three pairs of double-end-walled, concrete tanks filled with scrap metal. Metal banding obtained locally from lumber mills and rusty "tin" cans from the Sacramento area were charged to the tanks by a crane equipped with a clam shell or magnet. The tanks are 30 feet long and six feet deep; two pairs are eight feet wide and one pair 12 feet wide. They are operated in series or as pairs in series. Mine water is brought by gravity flow to the tops of the tanks, passed downward between the double end-wall, and was fed upward through the scrap by means of holes drilled in the wooden cover over parallel ditches in the tank bottom. They are cleaned in the fall and again in the spring. The high ferric iron content of the mine water causes a relatively high consumption of cans. Annual recovery amounts to 75 to 150 tons of cement containing 65 to 80 percent copper. It was formerly shipped to a smelter at Tacoma and currently to the company-owned chemical plant at Martinez.

J C L mine. Location: Sec 8, T. 31 N., R. 5 W., M.D., 3½ miles southwest of Redding. Ownership: Raymond F. Leonard, P. O. Box 1451, Redding, California.

Massive Copley Greenstone is cut by a limonite-stained shear zone six feet wide, the central and most distinct element of which strikes N. 24° W. and dips 88° E. It is joined on the east by, or perhaps curves into, a steeply dipping, gougey shear zone striking N. 65° W. Another wide shear zone parallels the first about 10 feet to the east. Apparent bedding strikes northwest and dips steeply east.

Mineralization consists of chalcopyrite with some pyrite and bornite; fan-like aggregates of malachite needles and sparse massive azurite occur in the oxide zone. Quartz stringers are common in the first shear zone and on a small dump; sulfide minerals are associated with the quartz but are rarely found in it. Sparse veins of calcite also are present.

Four drill-core samples 1.5 to 4.0 feet long contained 3.14 to 14.38 percent copper; one contained in addition 0.10 ounce per ton silver and a trace of gold. A 50-pound grab sample taken in 1960 contained 43.7 percent silica, 7.7 percent alumina, 13.5 percent iron (total), 3.1 percent lime, 10.9 percent sulfur, 1.5 percent copper, and a trace of gold and silver.

An old prospect pit on the property probably had been dug prior to the 1950's. Leonard and a partner prospected the area in December 1956 and located four claims in April 1957. Intermittent work done since then includes six diamond drill holes 18 to 22 feet deep, measured vertically (45 feet maximum length), and a bulldozer cut 30 feet deep. The property was idle late in 1962.

Mammoth mine. Location: Secs. 29, 31, and 32, T. 34 N., R. 5 W., M.D., about 3½ miles northwest of Shasta Dam. Ownership: United States Smelting, Refining and Mining Company, 921 Newhouse Building, Salt Lake City, Utah.

In the mine area, a small remnant of Kennett Formation lies conformably on the Balaklala Rhyolite and dips gently eastward. Portions of all three units of the Balaklala are present; the ore zone is in the uppermost part of the middle unit, immediately beneath the contact with the upper unit. A complicated but gentle structural arch has formed, cut by several faults that generally strike eastward and dip steeply northward. The principal fault zone, the California, has a horizontal component of movement of about 250 feet; it has offset some of the orebodies but probably is also a pre-mineral fault.

Orebodies are large, flat-lying, tabular masses of pyrite that locally contain significant amounts of copper or zinc; they are localized by the arch, steep fracture cleavage, and the middle unit of the Balaklala Rhyolite. Some secondary enrichment is present, and gossan is poorly developed. The ore zone is somewhat elongate in plan, trending to the northeast; it has an overall plunge of about 14 degrees to the west, measured from the gossan outcrop of the Main orebody. The entire zone is not ore, but minable masses of sulfide occur throughout the zone; the maximum ore thickness is 110 feet, and individual stopes have maximum horizontal dimensions of 500 by 900 feet.

Between 1905 and 1925, the Mammoth mine yielded 3,311,145 tons of copper ore containing an average of 3.99 percent copper, 4.20 percent zinc, 2.24 ounces per ton silver, and 0.038 ounce per ton gold. During 1914–1915, 84,000 tons of zinc ore were mined, averaging 21.10 percent zinc, 2.40 percent copper, 5.79 ounces per ton silver, and 0.078 ounce per ton gold.

The mine was extensively developed by thousands of feet of workings appended to nine principal adits driven at altitudes ranging from 2,426 to 3,096 feet; a few short, unconnected adits were driven at altitudes up to 3,250 feet. The main haulage level was the 470-foot-level adit, at an elevation of 2,820 feet, driven a little north of west for about 3,500 feet.

The Mammoth mine probably was discovered in the 1880's and before 1900 was worked in a small way for the free gold in its gossan. The Mammoth Copper Mining Company, a subsidiary of the U. S. Smelting, Refining and Mining Company, acquired the property in 1904. It was operated continuously from 1905 to 1919 and again from 1923 to 1925. A smelter built near Kennett in 1907 operated until 1919 and again briefly in 1924; it was dismantled in 1925.

In 1937, the 470 level was cleaned out and several thousand feet of diamond drilling, in holes averaging 150 to 200 feet long, was done.

Averill (1939, p. 175) noted the presence of about 20,000 tons of flue dust stored at the smelter; in 1947, C. E. Wuensch and C. T. McNeil shipped flue dust from the Mammoth smelter—presumably this same pile—to a smelter at Tooele, Utah. Recovery amounted to 3,381,073 pounds zinc, 1,631,173 pounds lead, 221,946 pounds copper, 46,918 ounces silver, and 378 ounces gold.

Shasta King (Lost Desert, Trinity) mine. Location: Secs. 1, 11, and 12, T. 33 N., R. 7 W., M.D., four miles northwest of Shasta Dam. Ownership: Shasta Minerals and Chemical Company, 826 South Main Street, Salt Lake City, Utah.

Balaklala Rhyolite is the only formation exposed at the mine. Ore is localized between a nonporphyritic member of the Balaklala and a thin, overlying bed of tuff and volcanic breccia. Faults are pre- and post-mineral in age; post-mineral movement amounts to at least several hundred feet.

The Shasta King orebody is a northeastward-trending, roughly basin-shaped lens of massive sulfide ore consisting of pyrite with some chalcopyrite, sphalerite, galena, and small amounts of gold and silver; the underground width of the orebody is about 500 feet and its maximum thickness 42 feet.

The mine is developed by a number of adits driven in a northerly direction into the orebody from elevations between 1,787 and 1,836 feet. The main haulage adit was driven for 800 feet a little north of west at an elevation of 1,816 feet. It entered the orebody about 225 feet west of the portal, and drifts were driven north and south. No. 11 adit driven west at an elevation of 1,636 feet was beneath the orebody. There are more than 15,000 feet of underground workings.

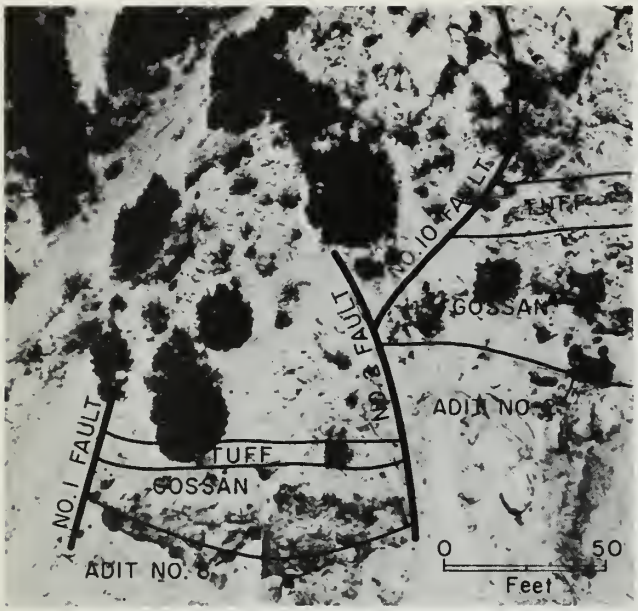


Photo 9. Shosto King mine as seen from the south.

The Shasta King mine was owned and operated by the Trinity Copper Corporation from 1902 to 1909, and the ore was shipped to the Balaklala smelter at Coram. These operations resulted in the mining of at least 15,000 tons of ore, but no record of the grade is known. The mine was idle from 1909 to 1917, but in 1918 the United States Smelting, Refining and Mining Company leased the property and operated it until March 1919. During their lease, 68,889 tons of ore were mined, averaging 2.92 percent copper, 1.01 ounce per ton silver, and 0.034 ounce per ton gold. Zinc was not recovered by the smelter (Kinkel and Hall, 1951, p. 3).

The Shasta King mine was one of the Walker Engineering Corporation holdings leased to the Shasta Copper and Uranium Company, Inc., on June 1, 1954. A Defense Minerals Exploration Administration loan of $52,286 was obtained to explore the property, and six diamond-drill holes were put down to an average depth of 500 feet by August 1956. This and other properties were also explored by the Shasta-Phelps Dodge Joint Venture during 1956–1957 (see Walker Corporation group in tabulated list). Early in 1961, the Shasta King was sold to Shasta Minerals and Chemical Company, the successor to Shasta Copper and Uranium.

Thompson (Wallis) mine. Location: Sec. 34, T. 33 N., R. 4 W., M.D., adjacent to the East Fork of Stillwater Creek about eight miles northeast of Redding. Ownership: Bessie A. Wallis, Redding, California.

Much of the Thompson property is covered by terrace gravel, soil, and brush, so that the principal exposures are in the main pit of the Flexiform Company and in the adjacent streambed of Stillwater Creek. The main pit is about 400 feet long in a northeasterly direction and has a maximum depth of 35 feet. Exposed in it are porphyritic and massive fine-grained varieties of greenstone, and small amounts of interbedded, silicified, fetid, dolomitic limestone; these rocks probably comprise part of the Dekkas Formation. Greenstone in the streambed has an apparent bedding that strikes N. 60° W. and dips 32° N. Disseminated pyrite is common.

Prominent mineralized shear zones capped by gossan are exposed in the streambed and the west wall of the pit; they are vertical and strike N. 20°–40° W. A zone about 25 feet wide in the deepest part of the pit

Photo 10. Northern open cut ot the Thompson copper property, 1958. This explorotion cut in gossan was made by the Flexiform Engineering ond Mining Compony. View N.35°E.

in 1957 contained almost-massive pyrite with some chalcopyrite, bornite, and quartz; it was capped by gossan about 12 feet thick. Most of this material probably was mined or else subsequently covered by slope wash and water; it was not visible in the pit late in 1962.

A bulldozer cut about a quarter mile east of the main pit exposed three veins of quartz in porphyritic greenstone or diorite; they strike northwestward, dip

Photo 11. Headfrome ond hoist house of Flexiform Engineering ond Mining Compony ot the Thompson copper property. The two-comportment shoft wos 60 feet deep.

to the east, and contain pyrite, chalcopyrite, bornite, and bands of sooty black chalcocite.

This area was first prospected during the 1890's, when a shaft was sunk in the creek bottom and chalcopyrite-bearing quartz was encountered. Ten samples of the gossan were reported in 1939 to average $5 per ton in gold (Averill, 1939, p. 154). The Flexiform Engineering and Mining Company, Inc., leased the property in 1957, opened the main pit, sank a two-compartment shaft to a depth of 60 feet, and prospected the surrounding area by bulldozer. The mill of the Washington gold mine at French Gulch was leased and renovated, and sorted ore from the zone of pyrite in the main pit was milled; a carload of copper concentrate was shipped to the smelter at Tacoma in 1958. The property has been idle since 1959.

GOLD

The recorded gold production of Shasta County amounts to more than 46 million dollars and is second only to copper in value. Production statistics were not recorded prior to 1880, but the gold recovered from 1848 to that date must have comprised an additional several million dollars. The distribution of the total value of production among lode and placer mining is not known precisely, but without doubt lode mining has been the more important.

Lode Mines

Lode gold was first mined in Shasta County in 1852, at the Washington mine in the French Gulch district, 20 to 25 miles west of Redding. This gold-quartz district has been the most important in the county and contains such well known mines as the American, Franklin, Gladstone, Milkmaid, Niagara, St. Jude, and Summit. Its total production is probably about 10 million dollars. Other gold-quartz districts include: Harrison Gulch (Knob), about 53 miles southwest of Redding; Iron Mountain, about nine miles northwest of Redding; Old Diggins, five and six miles north of Redding; Shasta, about six miles west of Redding; Squaw Creek, west of Shasta Dam; and Whiskeytown, about nine miles west of Redding.

In the French Gulch area, gold deposits are associated with a zone characterized by dikes of "birdseye" porphyry and numerous faults and other dikes. This zone is on the south flank of an eastward-trending arch that is expressed by windows of Copley Greenstone exposed through the otherwise pervasive cover of younger Bragdon Formation. Gold occurs in steeply dipping quartz veins in the Bragdon Formation and in gently dipping veins at the contact between the Copley and Bragdon. Auriferous veins in the Copley Greenstone usually are narrow and of poor grade. Zones formed by the intersection of veins with each other or with contacts between differing rock types are commonly favorable areas for the occurrence of gold.

Albers (1961) draws attention to the inferred "Spring Creek" thrust fault between the Copley Greenstone and Bragdon Formation as a favorable horizon for the occurrence of ore. Noting that rich gold-bearing veins in the Bragdon Formation must represent residues deposited from ascending hydrothermal solutions that came past the favorable contact, he points out that the possibility of finding additional ore at greater depth in mines that have not yet penetrated to this contact must be regarded as promising.

Most of the production from the French Gulch district has been obtained from free gold; descriptions of many properties indicate that sulfides account for only a small proportion—probably less than a tenth—of the total gold content.

Deposits of the Old Diggins district, which probably have yielded more than three million dollars in gold, are localized by a series of thin bands of Balaklala Rhyolite in Copley Greenstone. Some of the Balaklala here represents interbedded flows of pyroclastic rock, but some also may represent intrusive material. Gold occurs in massive quartz veins, some of which attain widths of tens of feet; values tend to be somewhat spotty, in one case (the Central mine) ranging from $3.40 to $80 per ton for large shipments over a five-year period (Logan, 1926, p. 166). About half the gold occurs in sulfides.

In the Shasta and Whiskeytown districts, gold occurs in several environments. Quartz veins in albite granite of the Mule Mountain stock are common, but they quite possibly are associated genetically with the Shasta Bally batholith. Contacts between Copley Greenstone or Balaklala Rhyolite and granitic rock also are favorable for the occurrence of ore. Gold in some mines of these districts is associated with dikes of "birdseye" porphyry in rocks of the Bragdon Formation, an environment similar to that encountered in the French Gulch district.

Massive sulfide ore of the East and West Shasta copper-zinc districts contains small amounts of gold. Gossans overlying some of the sulfide ore have been enriched residually in gold and silver and consequently were at first worked for their precious metal content. The small amounts of gold in the massive sulfide ore appear to be insignificant until the enormous production of some of the mines is taken into account. The Mammoth mine, for example, yielded 3,395,145 tons of ore that rarely contained as much as 0.1 ounce of gold per ton; yet its weighted average gold content of 0.039 ounce per ton (Kinkel *et al.*, 1956, p. 133) indicates a total gold production in excess of 132,000 ounces.

Some of the ore taken from pockets or rich shoots was rich enough to be worked in hand mortars and arrastres until stamp mills could be built. Most of the gold mined in Shasta County from surface or near-surface deposits was free and could be recovered by simple crushing and amalgamation. At a few of the early stamp mills, tables were installed following the amalgamation section to make a concentrate which was shipped to a smelter. It was not until 1934 that a flotation plant for gold was built in Shasta County, at the American mine. Flotation plants were built at the Washington mine in 1936 and at the St. Jude mine in 1941. A cyanide mill was built to treat the tailing and waste dump at the Midas mine in Harrison Gulch in 1915. Another cyanide plant was built at the Walker mine in the Old Diggins district in 1936 and worked intermittently until January 1941. The Mountain Copper Company built a cyanide plant of several hundred

tons daily capacity at Iron Mountain. Gossan ore was processed there from 1929 to 1942.

The period of greatest activity in the gold quartz mines in Shasta County was from 1904 to 1919, when the copper smelters operating at Keswick, Kennett, and Bully Hill paid a bonus for the quartz, which was needed to flux the copper ores. It was more advantageous to ship gold ores to these smelters than to mill them, so many of the old stamp mills were scrapped. Then, when the smelters closed down in 1919, many mines had no outlet for their ore and were forced to close down too. Unfortunately, the mines also had earned a reputation for shipping low-grade ore, and this discouraged the venture capital needed to reopen them.

A later period of notable activity, reflected in the statistics of gold production, occurred from 1935 to 1941. It was brought about by the government-decreed increase in the price of gold, and was terminated by the onset of World War II.

Ajax mine. Location: Sec. 28, T. 33 N., R. 6 W., M.D., about five miles north of Whiskeytown. Owners: August Herman and Les Ralston, Whiskeytown, California.

The Ajax mine is a relocation of an old property, which had long been idle and concerning which there is no published report. Two adits, one about 110 feet higher in elevation than the other, had been driven to explore a vein in granite porphyry that strikes northward and dips 70° E. The present owners have reopened caved portions of these adits. The upper adit trends N. 63° W. for 123 feet and then turns N. 23° W. for 68 feet. In March 1955, the decayed timbers of an old cave drift showed in the face of the adit. The hanging wall of the vein could be seen above the cave. The owners said that the vein was about 18 inches wide and had been stoped to the surface for a length of about 200 feet. The ruins of an old five-stamp mill remain on the property.

Photo 12. Portol of the lower adit of the Ajox gold mine, in Mod Ox Gulch north of Whiskeytown.

The lower adit was driven N. 67° W. toward the projection of the vein from the upper adit. After being driven about 570 feet, it intersected the vein but was too far south to have stuck the extension of the oreshoot; a raise to the north was started in 1962. At two places in the lower adit, one 225 feet and another 300 feet from the portal, scheelite appears under ultraviolet light. The proportion of scheelite was too low to encourage development for tungsten.

The property is worked intermittently by the owners.

American mine. Location: Sec. 7, T. 33 N., R. 6 W., M.D., and Secs. 12 and 13, T. 33 N., R. 7 W., M.D., about four miles northeast of French Gulch. Ownership: Hazel Gold Mining Company, c/o Park Channing, Balfour Building, San Francisco 4, California.

The American mine was located in 1886. Irelan (1888, p. 565) reported that the surface ore was very rich and that $2,000 worth was recovered in a hand mortar. It was credited with a production of $300,000 prior to 1914 (Brown, 1916, p. 778).

A gold-bearing quartz vein strikes N. 80° E. and dips from vertical to 80° S., cutting slate and conglomerate of the Bragdon Formation of Mississippian age. Both slate and conglomerate were encountered in the upper levels, but only slate is evident in the lower levels. The slate is crushed and broken near the vein, and small angular fragments are often surrounded and partly replaced by quartz. The quartz has a bluish-gray color owing to the inclusion of graphite from the slate. Arsenopyrite, galena, and pyrite are the only metallic minerals associated with the gold. The gold is free and was recovered by amalgamation in a 10-stamp mill by the early operators.

The property was developed by a series of adits driven on the north ridge of Cline Gulch at elevations between 2,500 and 3,150 feet. The lowest adit, No. 5, was driven northward 1,150 feet to the vein, and drifts were driven 150 feet east and 270 feet west. In the west drift, 60 feet west of the adit, a winze was sunk 210 feet, and drifts were run on the 100- and 200-foot levels. The drift on the 100-foot level showed black slate with numerous bands of white quartz in the face 110 feet east of the winze. Some good ore is said to have been found in the east drift on the 200-foot level (Averill, 1939, p. 131). Only the No. 3½ and No. 4 adits (at elevations of 2,840 and 2,620 feet) were accessible in 1957.

The last production recorded from the American mine was by the Abacada Mining Corporation in 1934. This company built a new flotation and gravity concentrator with a rated capacity of 60 tons per day, grinding to 100 mesh. The mill was operated for only a few months and was later moved to the Brown Bear mine in Trinity County. The American mine has been idle in recent years.

Blue Gravel mine. Location: Sec. 2, T. 31 N., R. 5 W., M.D., south of Benton airport in Redding. Ownership: City of Redding, California.

Placer gold was mined from this property for several years starting in 1915, and, according to Averill (1933, p. 60), the value of the gold produced totaled about $20,000. In the mid-1930's, operators working the gravel discovered a north-trending zone of gold-

bearing quartz stringers about five feet wide in the bedrock of Copley Greenstone. A two-compartment vertical shaft was sunk through 25 feet of gravel and for 75 feet on the vein, with levels at 60 and 100 feet. On the 100-foot level, drifts were driven 280 feet south and 150 feet north. The vein was stoped above the south drift to the 60-foot level for a length of 180 feet. The vein north of the shaft on the 100-foot level was two feet wide but the grade was too low to mine profitably. On the 60-foot level, a drift was driven south about 600 feet, where the vein is cut off by a vertical fault. The vein was stoped above this level for a length of about 300 feet.

The ore was soft and wet and was drilled with auger steel, and the stopes were timbered with square sets. Free gold was recovered from both oxidized and sulfide ore in a small milling plant in which the ore was crushed in a jaw crusher and ground to minus-40 mesh in a ball mill. About 80 percent of the gold was recovered by amalgamation, and a flotation concentrate was shipped to a smelter.

In January 1941, the property was leased to J. C. Larson of Sacramento and sub-leased to A. Carino, Joe Carino, R. H. Hewes, and George Stokes, who operated the mine as partners. Average production amounted to about eight tons per day, and the operators claimed that 85 percent of the assay value was recovered by amalgamation. The property was shut down on June 20, 1942, and the machinery and equipment sold. Since then it has been worked intermittently for short periods by lessees. There has been no recent production, and the mine has been idle since 1958.

Central mine. Location: Secs. 3 and 4, T. 32 N., R. 5 W., M.D., and Secs. 33 and 34, T. 33 N., R 5 W., M.D., in the Old Diggings district, about five miles north of Redding. Ownership: J. K. Johns, Joseph Shafter, Frank Broadbent, and Sonia Lanza, P. O. Box 174, Summit City, California, own four patented claims and a mill site.

Two parallel veins in Copley Greenstone strike north and dip 65° E.; all work has been confined to one of these, known as the Central. At an elevtion of 1,000 feet, a crosscut adit was driven 200 feet N. 65° E. to the Central vein. Drifts were driven 500 feet north and 200 feet south, and an oreshoot 230 feet long and six feet wide was developed. A second crosscut adit 200 feet lower was driven 956 feet to the vein, and drifts were driven 646 feet north and 218 feet south. In the south drift the vein was three to 10 feet wide and of low grade, and was cut off by a fault striking east. Crosscuts driven 75 feet east and 171 feet west failed to find the faulted vein. In the north drift, the vein was four to 15 feet wide, and an oreshoot 165 feet long starting 208 feet north of the adit was stoped to the upper adit.

The vein material is white quartz with some chalcopyrite and pyrite accompanying the gold. The ore was shipped to the smelter at Kennett. Tucker (1922, p. 494) reports a production of $45,000 in 1912 and a total production of $500,000 for the mine. The property has been idle since the copper smelters shut down in 1919.

Franklin and Milkmaid (Franklin, Milkmaid, Western) mine. Location: Secs. 8, 9, 16, and 17, T. 33 N., R. 7 W., M.D., about two miles northwest of French Gulch. Ownership: Mountain Copper Company of California, 100 Mococo Road, Martinez, California.

The Franklin mine was located in 1852, and the Milkmaid shortly thereafter. Little is known of the early activity at these properties, but by 1912 the Franklin mine had been developed by workings from three main levels. A 10-stamp mill was erected on the Milkmaid property around 1910. Production from the Franklin amounted to about $350,000 during 1907–1912 (Ferguson, 1914, p. 62). According to Logan (1926, p. 175), production from both properties was $496,000 from 1910 to 1922, and total production reportedly was 2½ million dollars. The mines were worked by Western Exploration Company or its lessees from 1907 (and probably earlier) to the 1940's. J. H. Scott Company leased them for several years in the late 1930's, when the mill was reconditioned and partially rebuilt, 2,350 feet of old workings were cleaned out and repaired, and about 350 feet of new drifts and raises were driven. After World War II it was owned by the Scott Company, and was acquired by its present owners in the early 1960's.

Ore deposits in the Franklin and Milkmaid property occur chiefly along the east-dipping contact between a sill of quartz porphyry and the structurally overlying Bragdon Formation. The sill was emplaced at the Copley-Bragdon contact; the mineralized zone strikes nearly north and has been traced for about 4,000 feet. The up-dip projection of the contact coincides with the mineralized contact zone at the Washington mine to the west.

Gold occurs in large, lenticular masses of quartz as much as 500 feet long, 200 feet wide (down dip), and 10 feet thick. Some gold also is found at the margins of the lenses in small quartz stringers the strikes of which are almost at right angles to that of the lenses. In the Franklin mine, a vein of quartz striking N. 70° E. and dipping 70° N. was found in the quartz porphyry sill; it was mined but apparently was not worked as far as the favorable contact with the Bragdon (Albers, 1965).

Ore consists of free gold, pyrite, galena, arsenopyrite, and sphalerite in quartz-calcite vein material. Very little of the ore has been oxidized or enriched.

Gladstone mine (French Gulch Mining Company, Hazel Gold Mining Company). Location: Secs. 7, 8, 17, and 18, T. 33 N., R. 6 W., M.D., about four miles northeast of French Gulch. Ownership: Hazel Gold Mining Company, 3126 Ebano Drive, Walnut Creek.

The Gladstone mine was located in 1887 and was worked by several different operators before 1901, when it was purchased by the Hazel Gold Mining Company. Its yield prior to that time was about $85,000 (Ferguson, 1914, p. 57). The new owners developed the mine to a vertical depth of 2,100 feet before they suspended operations in 1917. The recorded gold production from February 1901 to June 1912 was $2,389,491.78 in gold bar and $109,739.90 net in table

concentrates; annual production around 1912 was $360,000 (Ferguson, 1914, p. 57). Albers (1965) reports a total production through 1916 of 206,765 ounces of gold; projection of the data supplied by Ferguson is in close agreement with this value. There has been little production since 1916 and none since 1922.

The mine was worked to a depth of about 1,000 feet below the outcrop through six adits, then 1,400 feet deeper through a winze at the west end of the lowest (Ohio) adit. Thirteen levels were driven east from the winze at about 100-foot intervals. They range in length from about 600 to 1,300 feet.

The Gladstone vein strikes east and dips vertically from the highest outcrop to the Ohio adit level about 1,000 feet lower. From the Ohio adit level to the seventh level in the winze below the adit, the dip is 60° S., but below the seventh level the dip changes to steeply north. The country rock is slate, argillite, and meta-conglomerate of the Bragdon Formation. The vein, two feet to 22 feet wide, occurs in a crushed zone 60 to 70 feet wide and is made up of stringers of white to bluish-gray quartz. Gouge is nearly always present on the walls of the vein. The gold is mostly free, and pyrite, galena, sphalerite, and arsenopyrite are present in minor proportions in the vein material.

Three separate oreshoots raking steeply west were mined above the Ohio adit level. The two western shoots combine below the Ohio level and then rake steeply east; they were joined by the third shoot between the sixth and seventh levels, below which the rake probably was nearly vertical. Stopes were three to four feet wide and up to 300 feet long. The oreshoots have been mostly stoped to the surface.

The ore was milled in a 30-stamp mill. About 94 percent of the gold was recovered by amalgamation. Ore in the mill heads contained about $10 gold per ton on the average, but some ore contained as much as $80 per ton. Table concentrate, which amounted to less than one percent of the ore milled, contained about six percent of the gold.

Iron Mountain (No. 8, Old Mine) mine. Location: Secs. 34 and 35, T. 33 N., R. 6 W., M.D., about 15½ miles by road northwest of Redding. Ownership: Mountain Copper Company of California, 100 Mococo Road, Martinez, California.

The reddish-brown gossan lying above and north of the Old Mine massive sulfide orebody was sampled in 1909 and found to contain more than 500,000 tons of material, which would average $1.85 (at $20 per ounce) in gold and silver, if a feasible method of recovery could be devised. Pilot-plant tests made in 1928 indicated that a profitable extraction of the gold and silver could be made by the cyanide-leaching process. A cyanide plant with a daily capacity of 250 tons was built and put into operation in December 1929; the

Photo 13. Quarry in gold-bearing gosson over the Old Mine orebody, Iron Mountain.

capacity was raised to 600 tons in 1932. All gossan mining was suspended in February 1942.

The gossan from massive pyrite was limonite and hematite with very little quartz box work. The box work gossan was found on the fringes at the massive ore and consisted of thin walls of quartz lined with spongy red, yellow, or brown limonite. It was tabular-shaped with a maximum width of about 500 feet, and rose 1,800 feet in a northeasterly direction with a slope ranging from approximately 15 to 40 degrees. The maximum thickness was 250 feet just north of the Old Mine sulfide deposit, but as mining progressed northeastward the thickness decreased to a maximum of 75 feet. The overburden of oxidized and decomposed Balaklala Rhyolite increased from an average 3:1 ratio to a 5:1 ratio as mining progressed eastward.

Most of the gossan was mined from benches in a quarry. Holes were drilled in the toe of the bench with a jackhammer, and blasting broke and loosened the ore. The ore was loaded into dump trucks by power shovels and hauled about a quarter of a mile to the mill ore bins. Carryalls, scrapers, and rippers were used in mining the ore at the crest of the mountain. This ore was dumped at the edge of the quarry shelf by the carryall, and a bulldozer pushed it over the edge into the quarry floor, 400 feet below. About one-third of the gossan was mined underground by the top-slicing method to avoid stripping the deep overburden.

Averill (1938) described the cyanide leaching process in detail. The ore was crushed to minus ⅜ inch, and sands and slimes were separated in classifiers and leached in separate circuits. Gold was precipitated by the Merrill-Crowe process, mixed with fluxes, melted in a distillate-burning furnace, and poured into standard bullion molds.

The sections on copper, iron, and pyrite in this report contain descriptions of other operations at Iron Mountain.

Mad Mule (Banghart) mine. Location: Sec. 31, T. 33 N., R 6 W., M.D., at Mad Mule Mountain about 3½ miles northwest of Whiskeytown. Ownership: George S. Jackson, 18534 Vessing Road, Los Gatos, California.

This property was located and placered in the early 1850's. After the rich surface ground was exhausted, it was worked as the Banghart mine through a series of adits. Little of its early history is known. The Second Report of the State Mineralogist (1882, part 1, p. 149) notes that a 13-ounce specimen of crystallized gold from this mine was exhibited at the Paris Exposition of 1878, and in 1893, Hodson (p. 397) reported that 21 adits, the longest of which extended 1,400 feet, had been driven. The gold occurred in pockets and was quite coarse; it was milled in a large mortar with a spring-mounted pestle that was operated by hand.

Individual pockets yielded as much as $10,000 in gold (Crawford, 1894, p. 252). By 1912, production was estimated at about a million dollars (Ferguson, 1914, p. 52). During the winter of 1922–1923, a pocket was encountered that yielded between $7,000 and $8,000; two miners reportedly extracted $2,500 in gold that same season (Logan, 1926, p. 175). The last mining activity publicly reported was in 1926.

Workings reportedly total eight miles in length (Averill, 1933, p. 35), but in 1912, after the period of peak activity had passed, Ferguson (1914, p. 54) noted that few tunnels exceeded 200 feet in length.

Gold is associated with a gray dike of "birdseye" porphyry that contains thin needles of hornblende. The dike trends east and west and is exposed for 1,000 feet along strike; in its western part, it is 150 feet wide and dips 40° to 60° N., whereas to the east it thins to 12 feet and has a vertical dip. It separates slate and metaconglomerate of the Bragdon Formation on the north (hanging wall) from Copley Greenstone and Balaklala Rhyolite on the south. The wall rock on both sides of the dike is intensely sheared, but the dike itself is relatively unsheared.

Most of the gold has been taken from "points"—crests or troughs of folds, intersections between bedding and fault planes, intersections between bedding and the porphyry dike, etc. Small masses of calcite a few inches thick, three to four feet wide, and up to 30 feet long occupy areas of structural tension at the "points", and gold occurs in or immediately adjacent to the calcite. Some gold also occurs in small quartz stringers along and a few feet on either side of the porphyry-slate contact. Small veinlets and smears of pyrite—the only sulfide present—reportedly contain gold, but there is no record of the sulfides ever having been processed for their gold content.

Midas (Gold Hill, Harrison Gulch, Victor and Twinvict) mine. Location: Secs. 3, 4, and 10, T. 29 N., R. 10 W., M.D., in the southwestern portion of Shasta County at Knob, in Harrison Gulch. Ownership: Adele Moore, 608 Mid Rincon Road, Santa Rosa, California, owns 11 patented claims.

The Midas mine is one of the famous gold-quartz mines of Shasta County. It was discovered in 1894 and was operated continuously from 1896 to 1914 by the Midas Gold Mining Company. It was closed down in 1914 because of a fire in the underground workings. The reported yield was $3,563,587 in gold from 166,632 tons of ore, or an average recovery of $21.38 per ton; 76.83 percent of the gold was recovered during milling (Logan, 1926, p. 173–174).

Three veins, averaging 14 to 20 inches in width, strike N. 48° W. and dip 50° to 75° S.W. in schistose meta-andesite. The veins strike conformably with the schistosity of the country rock but dip at right angles to it. The Baldwin and Gold Hill veins are 400 feet apart and the middle vein lies between them. The quartz occurs in lenses, and the oreshoots were 14 to 16 inches wide and from 200 to 400 feet long.

The Baldwin vein was worked from a two-compartment shaft 1,500 feet deep with 14 levels containing more than 26,000 feet of drifts and 11,000 feet of crosscuts and raises. A 600-foot shaft on the Gold Hill vein is connected with the Baldwin shaft by crosscuts; both veins were worked from the Baldwin shaft below the 600 level. A fault striking N. 52° E. and dipping 60° S.E. cut off both the Baldwin and the Gold Hill veins on the 1,200-foot level. A drift following the fault plane from the Baldwin to the Gold

Hill vein, a distance of 435 feet, was continued beyond the vein for 50 feet without finding the faulted segments.

Milling equipment included a 20-stamp mill, a tube mill, six Frue concentrators, and a 100-ton cyanide plant. In 1912, 127 men were employed in the mine and mill, and daily production amounted to 53 tons. Costs per ton were distributed in 1912 as follows: development $1.86; mining $5.64; milling $0.58; general, $1.07; total, $9.15 (Brown, 1916, p. 793).

The Victor Power and Mining Company took over the property in 1915 and treated by cyanidation some of the tailings, waste dumps, and stope filling from the upper levels. The mine was unwatered to the 900-foot level and the drift on the Baldwin vein was driven an additional 1,400 feet in search of new oreshoots.

An inclined shaft was sunk on a small vein in the adjoining Victor claim and workings were driven on three levels; the vein was lost west of the shaft. A little ore was milled in a three-stamp Nisson mill. The veins in the Victor are thought to be an extension of those in the Midas mine.

Little work has been done at the Midas property since 1920.

Milton (Hope So) mine. Location: Secs. 31 and 32, T. 32 N., R. 5 W., M.D., a mile and a half southeast of Shasta. Ownership: Alfred and Ray Leslie of Shasta, California, own a claim and mill site.

The Milton mine was first active around 1907. In succeeding years, a two-compartment vertical shaft was sunk to a depth of 115 feet. This shaft is now caved, but according to the present owners, a crosscut had been driven south 50 feet to a vein on the 100-foot level and drifts had been run 240 feet west and 40 feet east. The vein was stoped to a height of 20 feet above the drifts. A pocket containing $45,000 in gold was encountered in the west drift; total production, according to Alfred Leslie, was about $200,000.

James Leslie of Redding acquired the property and operated it from 1939 to 1942. About 50 feet south of the caved shaft, a single-compartment vertical shaft was sunk 55 feet on the vein, and a drift at the bottom was driven 70 feet east. The ore was crushed in a jaw crusher, ground to 20 mesh in a ball mill, and the gold amalgamated on a plate; a sulfide concentrate was made on a Wilfley table.

In 1953, scheelite was noted in the mine dump and in shallow surface trenches east of the shaft. A small pilot mill was built in 1954, and a small amount of scheelite was produced from dump material in 1955. During 1961–1962, lessees operated a 25-ton Straub mill and extended the drift in the shorter shaft.

Photo 14. Headframe over 55-faat, vertical shaft at the Milton gold and tungsten mine. View narthwest.

Country rock in the vicinity of the mine is Copley Greenstone. The quartz vein is four feet wide, strikes N. 83° W., and dips steeply north. Scheelite is exposed in the shorter shaft and drift and is present in the dump of the older, 115-foot shaft. Parts of the vein are said to contain as much as 2 percent scheelite. The mineral fluoresces bluish white, indicating the absence of significant amounts of molybdenum.

Phota 15. Tungsten mill at the Milton gold and tungsten mine near Shasta, in 1954.

Miner's (Brunswick) group. Location: Sec. 19, T. 33 N., R. 7 W., M.D., about three miles west of French Gulch. Ownership: Mrs. Frank B. Rossi, Roseville, California, holds eight unpatented claims.

A quartz vein, one to fifteen feet wide, strikes N. 75° E. and dips 52° N. between a porphyritic-diorite footwall and a black-slate (Bragdon Formation) hanging wall. The quartz is iron stained and honeycombed, and there is some auriferous pyrite present in the vein and wall rocks.

The Miner's group is an old property first located in 1879. In 1906 it was acquired by the Brunswick Mining Company, which operated it for several years. It is credited with a production of about $100,000 prior to 1914 (Brown, 1916, p. 780).

The mine is developed by a main crosscut adit driven 1,100 feet S. 30° E. to the vein, a drift about 400 feet long, and raises 50, 100, and 150 feet high to upper adit levels. Most of the ore was mined from a stope about 200 feet long and six feet wide.

In 1941, the property was leased and operated by B. J. Angelich and his three sons. They mined ore from a stope about 110 feet above the main adit and drifted on a quartz-stringer zone 10 feet wide about 30 feet above the adit. The iron-stained quartz contained about $7 per ton in free gold. Auriferous sulfides raised the value of the ore an additional $3 to $4 per ton. The ore was treated in a mill which included a small jaw crusher, rake classifier, Pan American jig, amalgamation plate, two flotation cells, and two Wilfley tables. The mill was run intermittently when the accumulation of ore permitted. No production was recorded for 1942, and the mill was idle during the war years.

In April 1951, Fred Ray of French Gulch milled about 100 tons of ore, but the yield was small and the work stopped. The property has been idle since 1951 except for assessment work.

Niagara (Black Tom, Montezuma, Niagara Summit Mining Company, Scorpion) group. Location: Secs. 7, 8, 17, and 18, T. 33 N., R. 7 W., M.D., about 3½ miles northwest of French Gulch townsite, on a prominent east-trending ridge between Scorpion Gulch and Right Fork of French Gulch. Ownership: E. M. Clark, P. O. Box 11, French Gulch, California, and Walter K. Jansen, P. O. Box D, Lincoln, California, own 23 patented and 12 unpatented claims.

The Niagara property was located in 1857. By 1890, seventeen claims had been patented, and five adits 300 to 1,380 feet long had developed the principal vein system to a depth of 480 feet. An 18-stamp mill was in operation then, and about 50 men were employed in the mine and mill.

Seven of the 22 claims then comprising the property had been worked by 1894; according to Crawford (1894, p. 253), these were the Niagara, Scorpion, Summit, Centennial, Honeycomb, Jumbo, and Shea. The Centennial and the Honeycomb and Shea are described in the tabulated list under gold.

The Niagara claim (actually two claims, "North Niagara" and "Niagara No. 2") was situated north of the Honeycomb and Shea; except for its name it bears no significant relation to the Niagara mine, the principal workings of which are overlain by the Yosemite, Coleman, and Comet claims. The "Summit" referred to by Crawford probably was a claim situated in the northwestern corner of Section 18, adjacent to the Montezuma (in Trinity County) but lying chiefly east of the divide between Trinity and Shasta Counties. Since then, it has been confused in the literature with the Summit mine situated to the south in Summit Gulch, about midway between the Niagara group of claims and the Brunswick (Miner's group) mine. [Brown (1916, p. 799), for example, describes the workings of the Summit mine in Summit Gulch under the heading "Summit and Montezuma"; he apparently mistook the Summit mine for the Summit claim of the Niagara group.] The Summit claim has sometimes been called the "Niagara Summit". The accompanying figure shows the relative positions of the claims and mines mentioned in this description.

In 1896, lessees were driving an adit on the Scorpion claim, which had been located prior to 1890, in order to reach the older workings, and two other lessees were working on the Summit. The Niagara group is referred to as the "Black Tom" by Ferguson in 1914, but the origin of the name is not given. It had been idle since 1905, and total production was estimated at "somewhat under a million dollars" (Ferguson, 1914, p. 66). The Scorpion closed down in 1910 because of legal complications that arose following discovery of a new orebody.

The Niagara vein was mined again beginning in 1921, when lessees opened it up and began operating a mill at the Sybil (Accident) mine. This activity continued through 1923, but by 1931 the property was controlled by the Niagara Summit Mining Company. Late that year, James Blagrave and his son, lessees from French Gulch, mined oxide ore at the surface that reportedly contained $5 per ton in gold. Another lessee drove a crosscut during 1938.

The Lincoln Gold Dredging Company, consisting of Clark, Jansen, and others, leased the property in 1941 and built a mill to treat material obtained from numerous dumps in the area. The mill operated a short while in 1942 before closing down. Clark and Jansen purchased the property in 1946, but no significant work was done. Some iron-stained quartz stringers mined from open cuts on the Scorpion claim in 1949 yielded about $35 per ton when milled. In 1950, lessees installed a Huntington mill and amalgamation plates to mill some of the dump material on the Niagara group, but the operation was short-lived. The property since then has been idle except for assessment work.

Total production from the Scorpion claim is estimated at $150,000 (Albers, 1965), but this figure may be included in the production estimate given by Ferguson for the Niagara group as a whole.

The main Niagara workings consist of the O'Neil tunnel, which extends N. 30° W. for 1,250 feet, and the Barnes tunnel, which trends S. 55° W. for 2,170 feet and then swings west for 200 feet and northwest for 360 feet; halfway along this latter segment, a drift has been driven generally southwestward an additional 800 feet. The elevation of the O'Neil adit is 2,943 feet, and that of the Barnes 2,400 feet; the projections of

Figure 4. Map of area of Niagaro group mines. Claims and mines mentianed in the text are shown in bold. The area is a part of T. 33 N., R. 7 W., about three miles northwest of French Gulch townsite. The map is based principally on recards of Shasta County Tax Assessor and report by Grant (1932a).

the two adits cross near the center of the south boundary of the Yosemite claim. In all, there are ten levels and several thousand feet of workings that develop the property to a depth of 500 feet.

The Scorpion claim is developed by three adit levels, the lowest of which has a winze 105 feet deep. Oreshoots were stoped for 150 feet above the lowest level. The main adit on the Summit claim extends almost to the Montezuma workings.

The principal vein of the Niagara group strikes N. 70° E. and dips 70° to 75° S. It consists largely of quartz with minor calcite and has been displaced for 100 feet by a fault that strikes N. 35° W. and dips 70° W. The Barnes adit had been driven in an unsuccessful attempt to locate the faulted segment of the vein, but only a small amount of ore was ever found on this level in the southwestern part of the Yosemite claim. Wall rock is principally "birdseye" porphyry dikes in which are contained narrow "ledges" of black Bragdon slate that strike northwest and dip 50° to 65° southwest. Pyrite is widely distributed in the slate, porphyry, and quartz, and commonly is closely associated with galena. Arsenopyrite occurs in altered porphyry and in the quartz. Galena and sphalerite are most abundant in quartz near its contact with slate. Gold is chiefly free; auriferous pyrite and galena amounted to less than 2 percent by weight of the ore milled.

At the Scorpion mine, a quartz vein occurs along a fault that strikes N. 50° W. and dips 70° S. in sheared rocks of the Bragdon Formation. Quartz porphyry is present along the footwall. The winze below the lowest adit reportedly encountered in the porphyry a vein of galena 18 to 20 inches wide, in which were visible specks of free gold. The vein of the Summit claim is thought to represent an extension of the Scorpion vein.

Old Spanish (Deakin and Taylor, Enright) mine. Location: Sec. 31, T. 32 N., R. 5 W., M.D., a mile and a half southeast of Shasta. Ownership: Cassie M. Middletown, Redding, California.

The Old Spanish vein was prospected prior to 1890 and was found to contain free gold and a small proportion of sulfides. By 1894, a shaft 45 feet deep and an adit 210 feet long had been driven. There were three other veins on the property, but only the Taylor vein had any workings—a short adit connected with a shallow shaft—at that time. Two years later, adits 125 and 140 feet long had been driven on the two other veins, and a 90-foot vertical shaft had been sunk on the Spanish vein; eight men were employed. Ore was shipped to the smelter at Keswick, and activity probably ceased when the smelter closed in 1907. There was no further activity until 1932, when some of the old workings were cleaned out. No production from this later work is known, and there is no record of subsequent activity.

The strike of the Spanish vein is reported as due east or N. 70° E., and its dip vertical. The other veins are said to strike east or N. 70° W., with dips ranging from 50° to 70° N. A northwest-trending fault just south of the workings, together with some greenstone included in the granitic rock of Mule Mountain stock, probably is responsible for localization of the gold. Gold is free milling near the surface but is largely in sulfide ore at depths as shallow as 10 feet (Averill, 1933, p. 42). The accompanying sketch of the mine workings indicates that free gold was found in a pocket at a depth of 15 feet and possibly as deep as 42 feet.

Potosi (Muletown Consolidated, Spring Gulch Mining Company) mine. Location: Secs. 15 and 22, T. 31 N., R. 6 W., M.D., about two miles north of Igo. Ownership: Norman Lane, Knob Route, Redding, California.

The Potosi vein varies in width from 15 inches to four feet, strikes north, and dips steeply west. It is in Copley Greenstone just south of a plug of quartz diorite that probably is a satellite of the Shasta Bally batholith. The vein consists of limonite-stained quartz and free gold in the oxidized zone, but, within a few tens of feet of depth, it grades into quartz with pyrite. Pyrite also occurs in the greenstone wall rock near the vein.

The first ore produced from this property in about 1854 was from a 90-foot shaft on the south end. Here the vein was four to 16 inches wide and consisted of high-grade ore which was stoped for a length of 100 feet. The mine was patented in 1877 by a Mr. Jones. Subsequently a second shaft was put down, but there was no drifting from it. A third shaft 75 feet deep was sunk near the center of the property and drifts were driven 100 feet north and 110 feet south on sulfide ore.

In 1932, lessees installed a small mill on the property and milled oxidized dump material and some ore mined from open cuts. A surficial ore shoot just north of the 75-foot shaft yielded 16 tons of ore from which $1,110 in gold was recovered by amalgamation. The property was sold to the Spring Gulch Mining Company in 1932 and was operated for a year or two. It was idle until Mr. Stoll operated it briefly around 1945 to 1947. In 1954 or 1955, the mill was damaged by fire and all equipment subsequently was sold as scrap. Lessees sank a 75-foot, square-set shaft in 1961. No production has been recorded from the Potosi since 1933.

Reid mine. Location: Sec. 34, T. 33 N., R. 5 W., M.D., and Secs. 3 and 4, T. 32 N., R. 5 W., M.D., about five miles north of Redding. Ownership: Marie Shelton, 430 California Street, San Francisco, California, Lorena R. Erich, Box 66, French Gulch, California, and Brayton Wilbur own seven patented claims.

The Reid mine was the principal gold producer in the Old Diggings district, shipping 160 tons of ore per day to the Mammoth Copper Company smelter at Kennett from 1904 until the smelter closed down in 1919. The mine had another brief period of operation in 1922 to furnish quartz ore for flux to the Shasta Zinc and Copper Company's smelter at Bully Hill. The gold content of the ore varied from $4.06 to $30 per ton. Inasmuch as quartz was worth $2 per ton as a flux, there was no need to mine selectively. A higher average grade of ore probably could have been mined had it been necessary. Total gold production was said

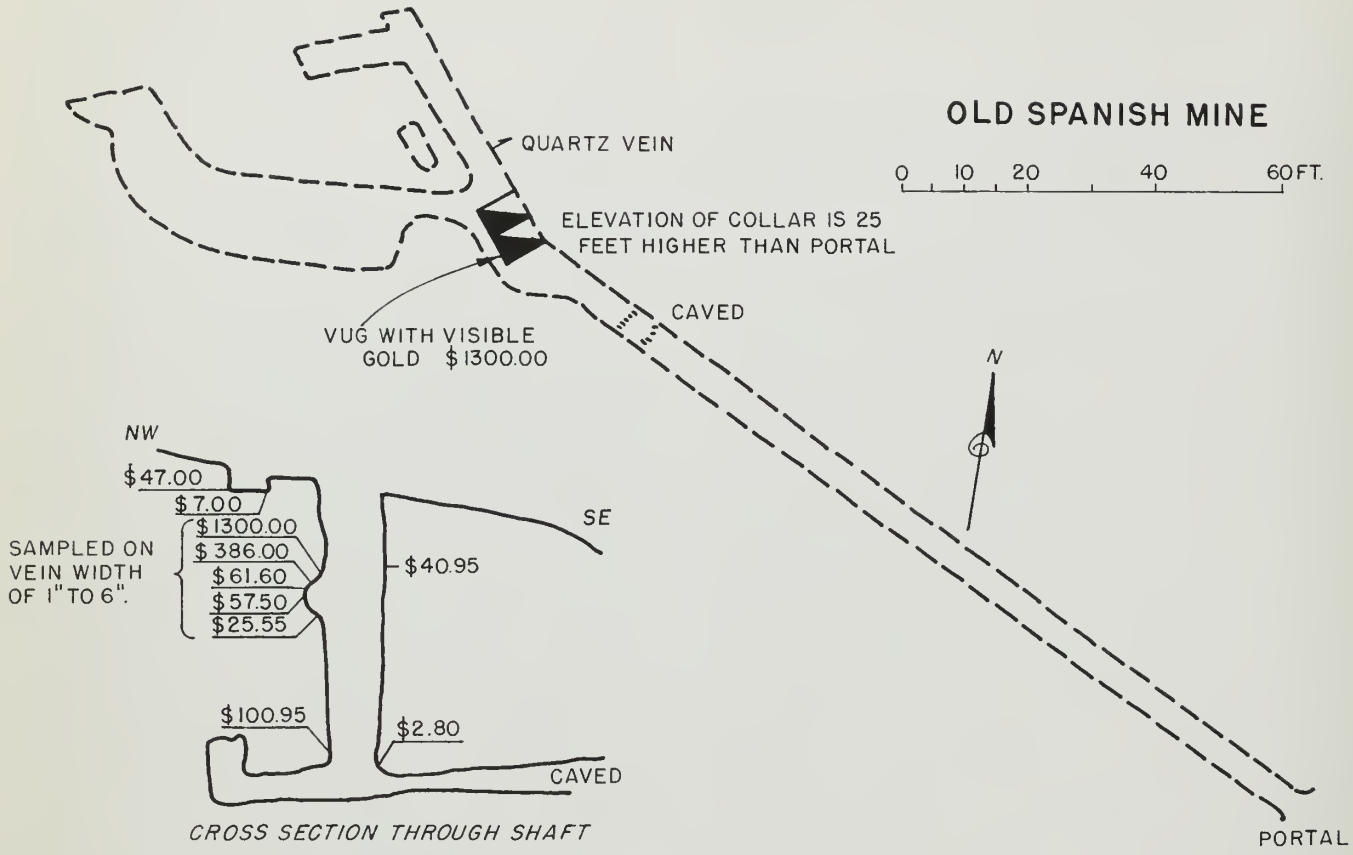


Figure 5. Sketch map and cross-section of Old Spanish mine. Gold assays are shown.

locally to have been valued at about $2,500,000 (Logan, 1926, p. 178).

The mine was worked from a perpendicular shaft 1,100 feet deep and an adit 1,000 feet long connecting with the shaft on the 200-foot level. There are eight levels at approximately 100-foot intervals below the adit level. A winze about 500 feet north of the shaft on the 800 level developed the ore to the 900 level.

The Reid mine includes a series of parallel veins striking north and dipping 70° E. in greenstone. The main vein varies from six to 30 feet in width and is composed of white sugary quartz. The gold is fine, alloyed with only a small proportion of silver, and is associated with pyrite and a small amount of chalcopyrite. The vein is offset by several cross-faults but the displacements are small.

The orebody was 30 feet wide on the 800 level and is said to have averaged $12 per ton in gold, but it narrowed to 16 feet on the 700 level. The orebody developed on the 900 level was estimated by H. W. Stotesbury to contain 14,290 tons of ore that would average $4.05 in gold per ton if mined to a width of seven feet and 34,380 tons averaging $3.50 per ton if mined to a width of 15 feet. The main oreshoot had a steep rake to the south and a maximum length of 600 feet. No stoping was done on the 900 level but the ore has been stoped out above the 800 level.

Several mines in the Old Diggings district, including the Reid, were under lease to P. A. Schwab and G. Cleveland Taylor in 1939. Some dump ore was treated in a flotation plant, but the recovery was poor and the operation was closed down (see Schwab and Taylor in gold section of tabulated list). The Reid mine has been idle since 1939.

St. Jude (Philadelphia and Roosevelt, Vogt) mine. Location: Sec. 17, T. 33 N., R. 7 W., M.D., three miles northwest of French Gulch. Ownership: St. Jude Mining Company, 4182 Greenwood Avenue, Oakland, California.

The St. Jude mine adjoins and is west of the Washington mine. It is developed by an adit driven N. 55° E. for 450 feet, then about 50 feet west, and then continuing due north about 750 feet. The adit cut three parallel veins striking N. 70° E. and dipping north. A thrust fault at shallow depth offsets these veins, so that they do not crop out at the surface. The six-foot-wide No. 1 vein was cut 700 feet from the portal and explored by a southwesterly drift, a 40-foot raise, and a stope 25 feet long and 25 feet high.

The No. 2 vein, cut at 1,050 feet from the portal, is split into two parts by a horse of quartz diorite six to 15 feet wide. In a drift driven northeast 75 feet and southwest 100 feet, the vein is 18 inches to four feet wide and has been stoped about 100 feet above the

level for a length of 100 feet. The vein material is white quartz containing pyrite, galena, and some sphalerite. Gold was visible in some hand specimens. The vein is 20 inches wide in a winze sunk 75 feet below the adit level.

The No. 3 vein, which is a continuation of the main Washington vein, was cut by the adit about 1,150 feet from the portal. It is four to seven feet wide and dips 70° north. Drifts were driven 100 feet southwest and 160 feet northeast. This vein was stoped out by the St. Jude Mining Company to an elevation equivalent to the "H" level of the Washington mine, which adjoins on the east. It previously had been stoped for 200 feet above the "H" level during 1939 by the J. H. Scott Company, operating under a royalty agreement.

A parallel vein about 60 feet north, known as the Dean vein, was intersected by a crosscut from the St. Jude adit on the No. 3 vein. This adit is within a few feet of being at the same elevation as the "H" sub-level (400-foot level) of the Washington mine. The Dean vein has not been developed in the St. Jude property.

Sorted ore from the St. Jude mine was sacked and shipped by truck to the smelter at Selby. In 1941 a mill was built near the portal of the adit. Free gold, amounting to about 50 percent of the gold content of the ore, was recovered from a Denver duplex jig and amalgamating barrel. The sulfides were concentrated by flotation and shipped to the smelter. The mill was destroyed by fire in September 1955.

The St. Jude mine yielded $283,717 from the sale of gold and silver between 1934 and 1946, according to the company records. Much of this ore contained gold and silver in a ratio of about 3½ to 1. There has been no production recorded from the mine since 1946.

Texas Consolidated mine. Location: Sec. 4, T. 32 N., R. 5 W., M.D., and Secs. 32 and 33, T. 33 N., R. 5 W., M.D., about six miles northeast of Redding. Ownership: Evelyn P. Joslyn, *et al.*, 94 Highland Avenue, Oroville, California, own eight patented claims and a mill site.

The principal productive period of the Texas Consolidated mine was around 1890. Mining was done by hand and the production amounted to about 40 tons per day with 75 men employed. Receipts for the sale of gold from this mine total $403,747, but gross production is thought to be about $750,000 (Averill 1933, p. 51).

There has been some production from each of three veins in the Texas Consolidated mine. The principal development, however, was on the middle vein. This vein strikes N. 10° E. and dips 70° east in Balaklala Rhyolite, which is in turn enclosed by Copley Greenstone. The width of the vein ranges from four to 14 feet. The ore was treated in a 20-stamp mill and the free gold recovered by amalgamation. The sulfides, chiefly pyrite and amounting to about 2½ percent of the ore treated, were recovered on tables and treated in a chlorination plant.

The mine was developed by five adits driven northeastward on the vein and connected through raises. Number 5, the main adit, was 1,600 feet long and reached a maximum depth of 910 feet below the surface. The oreshoot was about 600 feet long and 8 to 12 feet wide on this level. A winze below the Number 5 adit was about 400 feet deep with three drifts north and south spaced at intervals of 125 and 150 feet. The ore was stoped out from the lowest level to the top of the orebody above Number 2 adit.

In 1922 and 1923 crosscuts were run to the east and west from the Number 5 adit in a search for the extension of the vein, which had been cut off by a fault striking N. 40° W. About 1,500 feet of old workings were cleaned out in 1938–1939 (see Schwab and Taylor in gold section of tabulated list). The property has been idle in recent years and the adits are closed by fallen ground.

Uncle Sam mine. Location: Sec. 1, T. 33 N., R. 6 W. M.D., and Sec. 6, T. 33 N., R. 5 W., M.D., about 4 miles northwest of Shasta Dam. Ownership: Fred H. Dakin, *et al.*, 2811 Hillside Drive, Burlingame, California, own 140 acres of patented land.

The Uncle Sam mine is one of the best known gold-quartz mines in Shasta County. It was discovered in 1886 by J. Conant of Redding who sold it to the Dakin Company of San Francisco. The mine was operated by the Sierra Buttes Mining Company for several years prior to May 1913, and is credited with a production of a million dollars in gold from a maximum depth of 450 feet.

The main vein of the Uncle Sam mine strikes N. 80° W. and dips 55° north. Country rock consists of the upper, coarsely-porphyritic unit of the Balaklala Rhyolite, which in this vicinity forms an intrusive plug in one of the main conduits from which the thick accumulation of Balaklala flows and pyroclastic debris emanated. Small dikes of "birdseye" porphyry strike about N. 60° W. and dip vertically near the main adit portal.

The mine was developed by five adits, four of which were driven on the vein. The Number 5 adit, 550 feet below the outcrop, was driven as a crosscut adit N. 40° E. for 1,200 feet to the vein, and drifts were run 800 feet east and 700 feet west. The vein was 14 feet wide on the west end on this level. An incline was sunk 500 feet on the vein below this adit. The richest portion of the vein was toward the eastern end near the surface where it was intersected by a dike of porphyritic andesite. Three oreshoots pitching west on the main vein and another on a parallel vein about 100 feet north were stoped out.

The ore was crushed in a 30-stamp mill and a Huntington mill, and the sulfides concentrated on tables. Most of the gold was recovered by amalgamation, but the sulfides, which amounted to less than 2 percent by weight, assayed about $150 per ton in gold. The sulfides were roasted and the gold recovered by chlorination.

In 1923, the property was leased to the American Zinc, Lead and Smelting Company of St. Louis, Missouri. This company also had a lease and option on the Colma Copper Company group of claims which lie between the Uncle Sam and the Mammoth Copper Company group on the north and east. The trend of the orebodies in the Mammoth mine is S. 75° W. along

a shear zone thought to extend toward the Colma Copper Company group. The Number 5 adit of the Uncle Sam mine was driven 1,800 feet beyond its intersection with the Uncle Sam vein, and several hundred feet of diamond drill holes were run from stations near the face of this adit in an unsuccessful effort to locate this ore zone. Several quartz veins containing pyrite and chalcopyrite were intersected in the course of this work but they were not developed. Most of the rock encountered was Balaklala Rhyolite and quartz porphyry.

In 1936 and 1937, the Vera Mines Corporation did a small amount of development work but no production resulted. The High Divide Mining Company reopened part of the mine in 1945, and Continental Materials Corporation explored the property by bulldozing in 1961. There has been no production for about 50 years.

Walker (Josephine and Providence, Utah and California) mine. Location: Secs. 3 and 4, T. 32 N., R. 5 W., M.D., about 5 miles north of Redding. Ownership: John Pearl, 4019 McKinley Blvd., Sacramento, California.

The Walker mine was known as the Josephine and Providence mine until it was purchased by the Walker Brothers of Salt Lake City in 1888. They changed the name to the Utah and California mine but it since has come to be known as the Walker mine. The property includes 12 patented claims and additional ground amounting to 360 acres.

Country rock of Copley Greenstone is abundantly sheared in the vicinity of the mine, but portions of it are massive. Dikes or interbeds of Balaklala Rhyolite dip steeply and trend north-northwestward. The strikes of shear zones are chiefly N. 20° W. and N. 5° E. Massive veins of milky quartz with sparse sulfide mineralization appear to favor the N. 20° W. trend. There are six important veins on the property. The principal vein lies between walls of porphyritic rhyolite, strikes north, and dips 80° east.

The mine was developed by three adits known as the Josephine, Emmeline, and Main adits. The Josephine adit, the highest, was driven on the principal vein for 900 feet. The Emmeline adit, 70 feet lower, was driven 450 feet as a crosscut to the vein and then drifts were run 700 feet north and south. The Main adit, lowest of the three, was driven about 600 feet east to the vein; drifts were driven north and south on it and raises were run to the two upper levels. Several hundred feet of development work and some stoping were done on two other veins cut by the main adit. These veins strike northeastward and dip 60° northwest.

Production by 1896 reportedly amounted to 14,000 tons of ore (Crawford, 1894, p. 259). Most of it came from oreshoots 3 to 18 feet wide and up to 300 feet long. The gold, associated with pyrite and chalcopyrite, was treated in a 100-ton cyanide plant.

The Walker mine was purchased by the Dowling Mining and Investment Company about 1938 and was operated under the name of the Star Gulch Mining Company. The Santa Clara adit level, 80 feet lower than the Main adit, was driven S. 63° E. A 20-foot vein of quartz was intersected at 540 feet from the portal. Part of it was low grade, but a stope was started on the best 4- to 5-foot width. Two other veins, cut in extending the adit an additional 75 feet, strike N. 10° to 35° E. One has a vertical dip and the other, which dips steeply west, is three feet wide and was stoped to a height of 20 feet.

In March 1939, I. J. Finberg purchased the Walker mine from the Dowling Mining and Investment Company. New equipment was installed in the cyanide plant and the company treated about 30,000 tons of ore which were mined from an open pit above the Walker mine. The mine and mill were closed down January 1, 1941, and since then there has been no production reported from this mine.

Washington mine. Location: Secs. 16 and 17, T. 33 N., R. 7 W., M.D., about two miles northwest of French Gulch. Ownership: J. H. Scott Company, 634 Merchants Building, 465 California Street, San Francisco, California.

Two principal vein systems, called the "North-South" and "East-West", are present at the Washington mine. The North-South system strikes northward and dips about 45 degrees east to just below the I level, after which it flattens somewhat. It occupies the contact zone between sheared, graphitic slate of the Bragdon Formation in the hanging wall and massive Copley Greenstone in the footwall. Sills and dikes of quartz porphyry and "birdseye" porphyry have been emplaced along the contact zone, and locally cut both the slate and greenstone. The North-South vein is continuous in some places, whereas in others it consists of a closely-spaced group of quartz stringers.

The East-West system consists of fissure veins that strike about N. 70° E. and dip vertically to steeply south. A distinct gouge zone, ranging in thickness from a thin selvage to one inch, occurs on both the hanging and footwalls of the veins in this system. These veins are situated principally in greenstone, but, although they do not crop out on the surface, they extend above the more gently-dipping North-South system; at least one private report on the mine notes that the East-West system below the contact zone is relatively displaced toward the east. The greenstone is impregnated with pyrite for distances of 2 to 6 feet from the vein; tests during the 1920's indicated that sulfides accounted for 1 to 3 percent of the wallrock, with assay values of $8 to $40 per ton. Veinlets of quartz carrying auriferous pyrite extend into the wallrock immediately adjacent to the main vein.

Veins of both systems consist of quartz containing calcite, pyrite, sphalerite, galena, arsenopyrite, gold, and sparse chalcopyrite. Dump material at the I adit portal consists largely of greenstone containing abundant pyrite. White calcite veins up to 6 inches wide are marked by coarse cleavage plates; parallel to the walls are thin zones of pyrite masses and crystals, associated with and partially replaced by galena.

The Washington mine was located in 1852, and thus ranks among the earliest lode locations in California. The first work on the property consisted of sluicing the decomposed, oxidized outcrop of the North-South vein; the material was very rich, report-

edly containing as much as $600 per ton in gold. Ferguson (1914, p. 64) reports that the mine yielded $53,232 during the year following September 1853. By the end of 1855, three shallow shafts and three levels 97 to 522 feet long had been driven on the North-South vein. By 1865, a stope 500 feet long, 150 feet deep, and 12 to 25 feet wide had been excavated from the upper part of the vein, and about 2,000 feet of drifts and crosscuts had been driven to explore and develop it. A 22-stamp mill was on the property in 1869, and its production that year was $45,722 (Ferguson, 1914, p. 64); two years later, a production of $31,153 was reported. By 1890, total production was estimated at $500,000 to $600,000 (McGregor, 1890, p. 634). Ferguson (1914, p. 64) reports that the total was estimated locally in 1912 at between one and two million dollars. Much of this ore was treated only by stamps and amalgamation; some reports have estimated that recovery was as low as 50 percent.

The mine was continuously active until 1865, after which it was operated intermittently by lessees.

The two vein systems were developed by a series of six adits, named from top to bottom the Leadhouse, Trimbath, G, H, I, and J levels. The H level adit, which became the principal working level, had been driven N. 80° W. at an elevation of about 2,376 feet in order to reach the North-South vein exposed in the upper workings; it intersected the concealed East-West vein about 460 feet from the portal, and $100,000 in gold subsequently was mined from this area. The I adit was driven 220 feet lower to develop ore below the H level; this work reportedly yielded $50,000, but the ore was hand-sorted prior to milling, and much sulfide ore was used for stope filling.

The Dean vein was discovered 50 feet below the H level and 50 feet east. It is two to 12 inches wide, strikes N. 65° W. between walls of granite prophyry, and contains high-grade gold ore. This vein was worked by underhand stoping for a length of 100 feet to a depth of 65 feet.

In 1938, the stamp mill was replaced by a mill with a capacity of 35 tons daily in which a gold concentrate was recovered in a jig and then amalgamated, while a flotation concentrate was made of the sulfides.

Lessees recovered $2,300 in gold from 325 pounds of ore taken from a winze on the Dean vein 13 feet below the I level in 1955. Another 20 pounds of sorted material yielded $1,600. That same year, timbers in the H level burned out for 150 feet from the portal during a forest fire, and the adit caved.

In 1958, the Washington mill was renovated by lessees after 11 years of idleness, and ore from the Thompson copper mine was processed. Ore from the Combination gold mine was treated in 1959. During the first half of the following year, Ray Pearson and Loren Bliss milled some of the Washington dump, but without good results. In October 1960, Pearson developed surface exposures of lensatic, milky quartz by bulldozer, and ore was milled at the rate of 10 tons daily.

In 1962, the Esperanza Corporation, operators of the Yankee John gold mine, cleaned out and retimbered several hundred feet of the I level. Late in 1962 and during the first half of 1963, the property was inactive.

Workings consist of several thousand feet of drifts, crosscuts, raises, and stopes, originating from 6 adits. The uppermost or Leadhouse adit trends southwest at an elevation of about 2,200 feet, and exposes the North-South vein for about 2,000 feet. The next level, the Trimbath, was driven N. 85° W. at an elevation of about 2,600 feet; the North-South vein was intersected 210 feet from the portal, and a drift was driven on it for several hundred feet to the north. It is undeveloped south of the adit, probably because of a high sulfide content in the ore. The East-West vein was cut by the drift about 175 feet north of the adit.

About 330 feet east-northeast and 117 feet lower in elevation, the C adit was driven parallel to the Trimbath. It probably cuts the East-West vein 265 feet from the portal; a drift was driven west-southwest and then west for about 350 feet to the North-South vein. The H adit, beginning 107 feet below and about 200 feet east of the G portal, was driven N. 80° W. to the East-West vein, 460 feet from the portal. Drifts were driven on the vein and it was stoped to a height of 180 feet for a length of 200 feet; the western drift cut the North-South vein 310 feet from the adit. Additional drifting was done north and west of the intersection of the adit and the East-West vein. Crosscut drifts at distances of 113 and 240 feet from the portal were driven northward to the East-West vein. The North-South vein was intersected about 320 feet from the portal, but probably was not developed at this level.

About 400 feet east of the H portal and 220 feet lower in elevation, the I adit was driven N. 65° W. It cuts the East-West vein 470 feet from the portal, and then trends west and west-southwest for a total length of 1,600 feet. A raise passes to the stope on the Dean vein at 1,350 feet from the portal. The J adit is not connected with any of the other workings. It was driven for 500 feet at an elevation 257 feet below that of the I portal and only 13 feet above French Gulch Creek. Neither of the vein systems were intersected.

Whiskey Hill (Tom Cook) mine. Location: Sec. 28, T. 33 N., R. 6 W., M.D., about 4 miles north of Whiskeytown. Ownership: Archie Q. Adams, Hayfork, California.

A quartz vein 4 to 14 inches wide strikes N. 35° to 40° E. and dips 83° W. The vein material is composed of broken limonite-stained greenstone, sugar quartz, and a green, gritty gouge. Both walls consist of Copley Greenstone and are well defined.

Gold occurs in pockets, and the best ore is associated with the sugar quartz. The ore is sampled by panning, and some samples indicate that the ore in favorable zones contains several hundred dollars worth of gold per ton. According to Archie Adams, about 70 percent of the values are in free gold; the remainder, in sulfides, has never been recovered.

The vein was developed by three adits, but only the lower adit was open in 1957. This adit was driven on the vein for a length of about 200 feet to a raise which passed through the adits above and was being

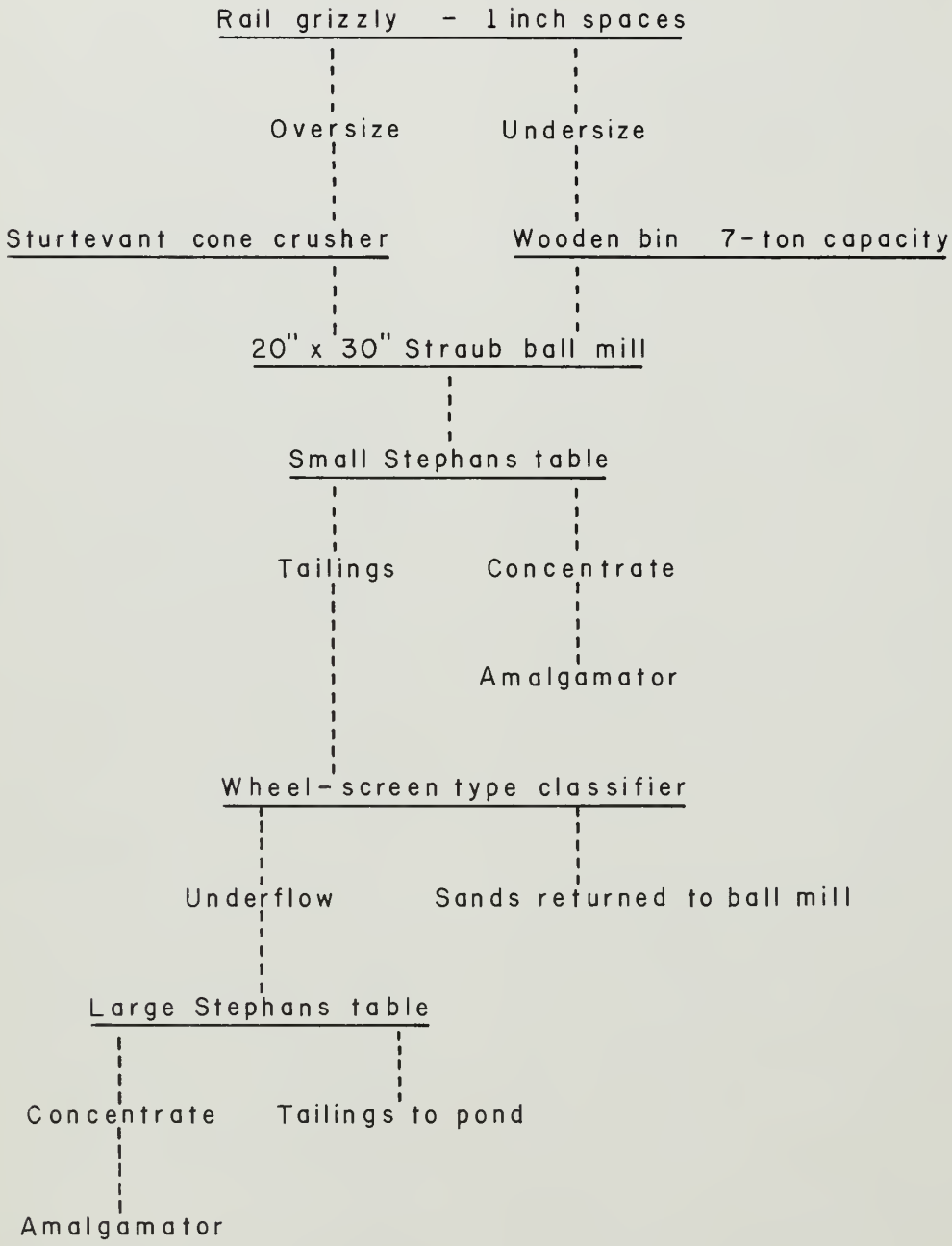


Figure 6. Flow sheet of Whiskey Hill mill, 1957.

driven to the surface for ventilation. The drift was driven five feet wide above the footwall by first picking down the ore about a foot beyond the face. Broken ore was loaded into a mine car and trammed to the mill ore bin near the portal. The flow sheet of a small milling plant capable of milling about one ton in three hours is shown in the accompanying sketch. Water for the mill was obtained by storing the mine water in a steel cylindrical tank, and power was generated by gasoline engines. The mill was run intermittently when enough ore had accumulated.

This mine probably was originally worked 70 to 80 years ago, inasmuch as a tree with 72 annual rings growing on the dump was cut down in 1962. Three claims, the Judy, Snow Bird, and Blue Bell, were located in 1941 by Tom Cook, who drove an adit on the vein. Around 1947, Jack (Shorty) Mason acquired the property, and some time after it was purchased by a Mr. Leonard, who drove another adit below and a raise up to the Cook adit. Lessees worked the property during the late 1950's, following Leonard's death. Archie Adams acquired the mine in 1960, cleaned out some of the older workings, and drove 400 feet of tunnel and raise. Claude Harris of Redding leased the property during 1962–1963.

Yankee John (Richstrike, Yankee Jack) mine. Location: Sec. 17, T. 31 N., R. 5 W., M.D., about 5 miles southwest of Redding. Ownership: Maurine Herrmman, 2611 Land Park Drive, Sacramento, California, owns 5 unpatented claims.

A series of parallel quartz veins in metavolcanic and mestasedimentary rocks of the Copley Greenstone strike N. 65° E. and dip steeply southeastward. Two principal veins are exposed 45 feet apart on the 100 level and 15 feet apart on the 200 level. The northwestern vein of the pair has a split that strikes from N. 75° W. to due west on the 100, 200, and 300 levels. On the 300 level, only one principal vein is apparent. Andesitic "birdseye" porphyry occurs in the hanging wall of the northwestern vein east of the split.

Some rich pockets have been mined from west of the shaft and above the 200 level, but the average gold content of the veins has been too low to permit continuous profitable operation. An assay map of the principal workings presented by Hollister (1949) shows the distribution of values to be quite erratic; assays range from a trace of gold to $155.75 per ton. Free gold, which contains some tellurium and is alloyed with silver in approximately equal amounts, is associated with calcite, pyrite, and arsenopyrite.

The mine is developed by surface cuts, an adit, and a two-compartment shaft 320 feet deep with levels at 60, 98 (100 level), 164, 198 (200 level), and 278 (300 level) feet below the collar. The adit was driven S. 20° W. for 150 feet, at an elevation 30 feet below the shaft collar. On the 66-foot level, a main drift and several laterals explored a zone 40 feet wide for a distance of 160 feet west of the shaft. An area 70 feet wide was developed for 200 feet west of the shaft on the 100 level. At 164 feet below the collar, a drift was driven 70 feet south from the shaft, to a point beneath the discovery stope.

Photo 16. Headfrome of the Yonkee John gold mine, southwest of Redding. The headfrome surmounts a 320-foot vertical, double-comportment shoft.

On the 200 level, a crosscut drift was driven 30 feet north from the shaft, cutting both of the principal veins. On the northwestern vein of the pair, drifts were run 240 feet in both directions; beginning 60 feet southwest of the crosscut, a drift follows the vein split west for 130 feet. The southeastern vein of the pair was explored by a drift driven N. 60° E. for 85 feet. A third drift on this level was driven directly from the shaft, N. 80° E. for 170 feet. On the 300 level, a crosscut drift was driven 10 feet north to the vein, then S. 65° W. for 220 feet. Northeast of the shaft, a block of ground 20 to 60 feet wide was explored for a distance of 190 feet.

The mine was worked as early as 1858. The discovery stope was worked by James Loage until 1862, after which there is no record for several years. In 1880, the mine yielded $15,000, and in 1887, $3,000. Between 1891 and 1907, another $15,000 was mined. The Yankee John Company was formed in 1907, and subsequently sank the main shaft and drove 2,000 feet of drifts, raises, and stopes. The company failed and the mine was sold in 1923. From 1926 to 1932, according to Hollister (1949), it yielded $83,000; he estimates the total production at $216,000, including $100,000 reportedly taken from the discovery stope.

In February 1940, A. G. Codigan operated the mine under a lease and extended the drifts southwestward on the 100 and 200 levels. A raise was driven from the 200 to the 100 level, and some stoping was done off the raise. The ore was treated in a small mill consisting of a jaw crusher, ball mill, classifier, jig, sluice boxes, and two flotation cells. The mine was idle from 1942 to 1945.

From 1945 to March 1948, the mine was operated by a succession of lessees, including Austin Merrill, Sidney Smith, Maurine Herrmman, Norman Lane, and Peter McDonald. In mid-1948, Smith and Lane discovered a pocket of gold between the 98- and 66-foot levels, and extracted about two tons of rich ore that was "milled" by crushing in a hand mortar and panning. From October to December 1948, the Igo Mining Company leased the property, and according to Hawe, one of the principals, recovered $18,000 in gold from 25 tons of ore shipped to the Selby

smelter. From December 1948 to March 1949, the property was operated by the Shasta Mining Association, working with the Igo Mining Company under an option to purchase, and some ore was mined from a raise between the 164- and 98-foot levels.

The mining equipment was removed from the property, and the mine was idle from March 1949 to December 1, 1950, when the Sebastian Mining Company purchased the lease. A compressor, hoist, and pump were installed, and the mine was unwatered below the 200-foot level. A small milling plant, which included a jaw crusher and a Hamilton centrifugal mill, was installed to treat mine dump material, but the milling plant was not completed. The property was idle from June 1951 to November 1956, when the Esperanza Corporation of Salt Lake City acquired the lease. The mine was pumped out and the shaft retimbered. The mill was renovated and enlarged to include a jaw crusher, ball mill, rake classifier, four flotation cells, a thickener, and filter. Underground work was concentrated on the 100 and 200 levels until late 1962; the property has been idle since.

Placer Mines

Gold was first mined in Shasta County in the spring of 1848, when Pierson B. Reading returned from investigating Marshall's discovery at Coloma and panned gold from a bar on Clear Creek, about seven miles west of the Sacramento River.

The streams flowing into the Sacramento River from the west were rich in placer gold and attracted several hundred miners before 1849. Villages such as Briggsville, Horsetown, Middletown, and Shasta had many substantial buildings and were thriving communities before 1855. Now, with the exception of Shasta, which has been established as a State Historical Monument, little trace of them remains.

The first placer miners worked with shovel and pan but soon learned to build rockers, long toms, and sluice boxes, which greatly increased the amount of gravel one man could wash. Hydraulic mining was made possible in 1855 when a ditch from Clear Creek near Tower House was completed to a reservoir above Middletown. Branch ditches carried the water to extensive areas of "dry diggings" along its route. The principal hydraulic operations were at Horsetown, Igo, Rock Creek, and in an area south of Whiskeytown.

Attempts were made to operate drift mines in the vicinity of Centerville, Igo, and Ono around the turn of the century and into the 1920's, but the operations were either not profitable or only marginally so and hence were short lived.

The first dredge in Shasta County was built by the Diestlehorst Brothers of Redding on the Sacramento River near the mouth of Middle Creek around 1895. It consisted of a scoop attached to the end of a shaft about three inches in diameter and 25 feet long, mounted between two sections of a boat. The scoop was lowered into the gravel and pulled up with chains operated by a steam winch, and the gravel was washed in sluice boxes. Other early dredges employed suction pumps and hydraulic elevators to raise the gravel. One dredge used a steel caisson in which a diver could work on the bottom of the river and flush gravel to the mouth of a suction hose with a stream of water under 100 pounds pressure.

The first bucketline dredge in Shasta County was put in operation on Clear Creek near Horsetown in 1906, and the first production from dragline dredges was recorded in 1935. The last bucketline dredge operating in Shasta County was shut down in 1951, and the last dragline dredge operated intermittently during the 1950's.

The productive placer mining areas in Shasta County are nearly all west of the Sacramento River, as streams entering the river from the east drain nonauriferous bedrock, barren Tertiary and Cretaceous sediments, and unmineralized volcanic rocks. An exception, apparently, is the Lucky Spot property a mile northwest of Ingot, where coarse gold was found associated with a sticky clay beneath an overburden of mudflow debris of the Tuscan Formation(?) (Averill, 1933, p. 67). Placer gold occurs in three principal environments in Shasta County: Holocene and Pleistocene(?) alluvium and stream channel deposits, gravels of the Red Bluff Formation, and dissected terrace gravels related to the present drainage system.

Specific data as to the quantity of gold recovered from these different sources are incomplete, but probably the stream channel deposits have been the most productive, if small-scale washing of residual gold concentrated locally near subsequently-worked lode deposits is not considered. Information on the gold content of gravels and/or fineness of gold is presented in the tabulated list or text for 12 operations in stream gravel and 3 in the Red Bluff Formation. Comparison of the data is difficult because some are expressed in terms of gold valued at $20.67 per ounce (the price that prevailed until 1932) and others at $35.00 per ounce; some reports give the total quantities of gold and silver recovered, and others give only the fineness; and some values are expressed in terms of cents per yard, whereas others are presented as total recovery. These data have been converted to show the fineness of the gold (either reported directly in the literature or else calculated from the ratio of gold to silver) and the quantity of gravel that was washed in order to recover one ounce of 1,000 fine gold; specific areas are discussed below.

The Columbia Construction Company processed about 3⅓ million yards of gravel from the Sacramento River channel and its west bank at Redding during construction of Shasta Dam; data for two years of operation show that between 666 and 1,000 cubic yards of gravel were washed for each ounce of gold recovered. It should be noted that this company was processing sand and gravel, and hence made no attempt to maintain a low ratio between gravel washed and gold recovered. The gold was 893 to 904 fine, a value confirmed by an earlier operation just north of Redding, where gold reportedly was 919 fine. In 1961, Shea Sand and Gravel recovered from the Sacramento River south of Redding 25 ounces gold and 2 ounces silver as a byproduct from 40,000 cubic yards of gravel. This is equivalent to gold that is 926 fine.

About 1,600 yards of gravel were washed for each ounce of gold recovered; this relatively low ratio may have been caused by Shasta Dam, which, since its completion in the mid-1940's, has prevented downstream transportation of placer gold.

Two operations along Cottonwood Creek washed 173 to 200 yards of gravel for each ounce of gold recovered; fineness ranged from 935 to 967. One operation on Clear Creek washed only 13 to 83 yards of gravel for each ounce of gold, and the fineness apparently was 950, an unusually high value. Three other operations on the same stream washed from 86 to 356 yards for each ounce recovered, and fineness ranged from 875 to 919. Data are available for one operation on each of the following streams, the names of which are shown together with the yards washed for each ounce, and the fineness of the gold: Churn Creek, 81 yards, 868 fine; Flat Creek (east of Centerville), 166 yards, 948 fine; Roaring River, 417 yards, 913 fine; Cline Gulch (near French Gulch), 555 yards, 900 fine.

Gravels of the Red Bluff Formation were hydraulicked in many areas during the 1860's through 1880's, but no information on the recovery during these operations is now available. Three more recent operations show that the fineness of gold in this formation ranges from 822 to 875. Red Bluff gravel was mined by drifting south of Igo (see Russell mine, herein) around the turn of the century. Later sampling in undrifted ground indicated that 66 to 166 yards of gravel would have to be washed for each ounce of gold. A "particularly rich" channel on this property later was mined by power shovel, and between 42 and 59 yards were washed for each ounce. One especially rich block of drifted ground amounting to about 24,000 yards probably yielded gold at the rate of one ounce for each 8.3 yards washed.

Although these values seem higher than those for the stream-channel gravels, it must be remembered that drift mining usually avoids the "overburden" of relatively barren gravel, whereas dredging or hydraulicking operations usually must process the entire vertical thickness of gravel. The block of rich ground at the Russell mine is a case in point. Half of an area 200 by 725 feet was removed by room-and-pillar breasting to a height of 8 to 10 feet. The total thickness of gravel at this point is not known, but it ranges from 18 to 80 feet over the property as a whole. Hence, any bulk mining method here must have moved between two and nine times as much gravel as did the drift miners; balanced against this must have been the additional recovery represented by the pillars. Another factor to consider is that drift mining can selectively remove gravel not only vertically, but also horizontally, whereas dredging or hydraulicking must move lower-grade gravel between the portions of richer ground.

B. H. K. Mining Company. Location: Sec. 34, T. 32 N., R. 6 W., M.D., at Boulder Creek, four miles south of Whiskeytown. Ownership: Robert Litsch and Roy C. Connelly, Shasta, California, own 80 acres.

The B. H. K. Mining Company, a partnership including E. D. Bishop and Louis Krantz of Orland, operated a dragline dredge at this location on Boulder Creek from November 15, 1941, to May 15, 1942.

The dredge processed 174,400 cubic yards of gravel, recovering 1,099 ounces of gold and 152 ounces of silver. The gravel was 8 to 22 feet deep above a hard bedrock and there were many boulders of quartz diorite.

The gravel was dug by a P. & H. dragline equipped with a 1½-cubic-yard bucket. The hull, built on steel pontoons, was 22 feet wide, 36 feet long, and 36 inches deep. Gravel was directed to a trommel 48 inches in diameter and 24 feet long, having 12 feet of ½-inch screen. Oversize material was not stacked but slid into the pond through a chute. Undersize material was fed into two sluice boxes 12 feet wide and 12 feet long, both on the same side of the trommel, one mounted above and discharging into the other. The lower box discharged into a downstream sluice box five feet wide and 20 feet long. All sluice boxes were lined with expanded metal over rubber matting. Mercury was placed in the sluice boxes to catch the fine gold.

Clear Creek Dredging Company. Location: Sec. 28, T. 31 N., R. 5 W., M.D., about 8 miles southwest of Redding, and Sec. 2, T. 29 N., R. 6 W., M.D., on Cottonwood Creek about 12 miles west of Cottonwood. Ownership: a partnership composed of George Bibbens, Dave Hinds, and Frank Walthall of Redding, California, owned and operated two dragline dredges.

A dragline dredge was operated from December 1940 to June 1941 on land in Section 28, leased from Mrs. W. N. Simmons of Redding. From 3 to 12 feet of red top-soil was stripped from the gravel and discarded. The gravel was dug 6 to 7 feet deep to a soft shale and tuff bedrock. About a third of the gravel handled consisted of old placer tailings which the operator said contained almost as much gold as the virgin ground. There were many cobbles of quartz diorite, granodiorite, and conglomerate.

About 2,000 cubic yards of gravel were dug in three shifts by a Northwest dragline equipped with a 2¼-cubic-yard bucket. The Judson-Pacific washing plant was built on six steel pontoons making a hull 36 feet wide, 45 feet long, and 42 inches deep. Pond and washing water was purchased from the Townsend ditch and pumped 1,500 feet against an 80-foot head. Gravel was fed to a trommel five feet in diameter and 28 feet long, having 20 feet of ½-inch to ⅝-inch screen. Trommel oversize was discharged to a 50-foot stacker belt, and undersize to eight cross sluices 30 inches wide that fed to two 30-inch downstream sluices 22½ feet and 37½ feet long, arranged in series on each side of the trommel. The sluices were fitted with Hungarian riffles.

The Clear Creek Dredging Company operated a second dragline dredge on Cottonwood Creek in Section 2, about 12 miles west of Cottonwood, beginning on June 25, 1941, and continuing through part of 1942.

At this location, the gravel was about 14 feet deep above a volcanic ash bedrock, and contained many cobbles of quartz diorite, granodiorite, conglomerate, and greenstone. It was tested by shafts and churn-drill holes sunk to bedrock, and the gold was washed and panned from measured amounts of gravel.

About 2,500 cubic yards of gravel were mined each 24 hours by a Northwest dragline equipped with a 1½-cubic-yard bucket. Gravel was washed in a Bodinson-built plant, which rested on five steel pontoons making a hull 30 feet wide and 40 feet long. The trommel was 54 inches in diameter and 28 feet long with 16 feet of ⅝-inch diameter holes. A stacker belt 50 feet long handled the trommel oversize. Seven cross sluices and two downstream sluices 26 inches wide on each side of the trommel, all fitted with Hungarian riffles, recovered gold from the trommel undersize. A pump driven by a diesel engine supplied 600 gallons of water per minute from a sump 600 feet west of and 50 feet lower than the washing plant.

French Gulch Dredging Company. Location: Sec. 15, T. 33 N., R 7 W.. M.D., on Clear Creek about two miles north of French Gulch. Ownership: French Gulch Dredging Company, a closed corporation, Etheridge Walker, President, 2404 Russ Building, San Francisco, California.

Gravel at this site on Clear Creek was 15 to 20 feet deep above a hard slate bedrock. The deposit was sampled by drilling 6-inch-diameter holes to bedrock with a Keystone drill and then washing and panning the gold from measured amounts of gravel. The holes were spaced at 50-foot intervals across the channel and extended 800 feet along the channel. The gold recovered by the dredge was said to have checked the sampling fairly closely.

A bucketline dredge was erected on the site in 28 days by a crew of 12 men. Digging started September 2, 1940, and about 4,000 cubic yards of gravel were dug each 24 hours. The dredge was closed down during World War II, and subsequently completed operations on Clear Creek on July 28, 1946, after which it was moved to Indian Creek in Siskiyou County.

The dredge hull, composed of 35 steel pontoons, was 85 feet long, 40 feet wide, and seven feet deep. The digging ladder was 85 feet long and carried 75 buckets, each with a capacity of 4½ cubic feet. The stacker belt was 85 feet long, and the trommel was five feet in diameter and 21 feet long, and had a screening section with ⅜-inch and 1½-inch holes. Trommel undersize was discharged to four sluice boxes 30 inches wide and 10 feet long; on each side of the trommel these discharged to downstream sluices 30 inches wide and 40 feet long. All slices were fitted with rubber Hungarian riffles. Wash water was supplied by eight- and 10-inch centrifugal pumps, and all equipment was driven by electric motors.

Lincoln Gold Dredging Company. Location: Sec. 34, T. 33 N., R. 7 W., M.D., on Clear Creek two miles south of French Gulch. Ownership: E. M. Clark of French Gulch, California, and Walter Jansen of Lincoln, California, own the mining rights on four claims owned by Florence Brady.

Phata 17. Washing plant of the Lincaln Gold Dredging Company, 1947. Dragline baom is visible in the background. Eight crass-sluices and a longitudinal sluice were used in the washing plant an each side af the trammel.

Phato 18. Flaating washing plant af the Lincaln Gald Dredging Company on Clear Creek near French Gulch, August 1947. Fine tailings were discharged through long pipe at rear of plant, covering the caarser tailings which dropped to the edge af the pond directly fram the trommel.

Gravel at this location was four to 12 feet deep above a soft slate bedrock. It included cobbles and pebbles of quartz diorite, rhyolite, greenstone, slate, and meta-conglomerate.

The Lincoln Gold Dredging Company operated a small dragline dredge at this location from June 1 to July 1, 1942, and from June 23, 1947, to October 8, 1948. For the second interval of operation, Clark redesigned and rebuilt the washing plant so that it would leave the tailings almost level, with the fines on top instead of at the bottom as is the practice with most dredges. This was accomplished by using a horizontal trommel in which the gravel was moved forward relatively slowly with a spiral conveyor and discharged into the pond. After flowing over sluice boxes, the sand was collected in sumps on either side of the trommel, and hydraulic elevators threw it out and over the coarse tailings.

Phata 19. The Olsan dragline and washing plant an Newtan Creek north af Redding, June 1947.

From 2,400 to 2,800 yards of gravel per 24 hours were excavated with a Northwest dragline fitted with a 1½-cubic-yard bucket, and discharged to a trommel that was 64 inches in diameter and 40 feet long with 20 feet of screen. It made eleven revolutions per minute and the spiral conveyor moved the gravel forward 54 inches for each revolution. Trommel undersize passed through eight cross sluice boxes, 32 inches wide and 10 feet long, on each side of the trommel. These discharged the sands into a downstream sluice and thence to the sump. Gold was recovered on a 12- by 30-inch copper amalgamating plate at the head of each sluice, or in the sluice-box lining of expanded metal over cocoa matting. The hydraulic elevators were equipped with a two-stage, six-inch-diameter centrifugal pump, and a 12-inch-diameter discharge pipe.

Russell (Blue Bird, Igo Mining Corporation, Igo Placer Mining Company, Lost Channel, Western Contracting Company) mine. Location: Sec. 34, T. 31 N., R. 6 W., M.D., and Secs 3 and 4, T. 30 N., R. 6 W., M.D., ½ to 1½ miles south of Igo. Ownership: Ione Crews and Harold Statton, 1731 Pine Street, Martinez, California. This property at one time consisted of as much as 580 acres of land, 210 acres of which were patented.

It was located by Thomas White of Igo as the Blue Bird drift mine of 20 acres in 1865, but little is known of its early operation. By 1894, White had driven a main bedrock tunnel 120 feet long. The property subsequently was acquired, together with 560 acres of ground adjoining mostly on the south, by C. A. Russell of Igo. By 1913 several tunnels had been driven, the longest of which extended for 1,800 feet, and several shafts 50 feet deep had been sunk. Tucker, writing in 1922, reported that there were 7,000 to 8,000 feet of workings near the Dunham tunnel, on the south side of Dry Creek; this undoubtedly represents work done earlier than around 1910. At an indefinite time prior to 1913, probably around 1910, some lessees unsuccessfully worked gravel in about five acres of ground with a shovel, rotary grinder, and an amalgamating plate.

Beginning in 1913, an extensive program of testing was undertaken to assess the suitability of the ground for dredging. Approximately 38 holes were drilled to depths of 50 to 65 feet along the township line, spaced 100 feet apart. North of the Dunham tunnel, 12 shafts were sunk 200 feet apart along an east-west line to depths ranging from 18 to 80 feet. In the early 1920's, a shaft was sunk 34 feet to bedrock of Los Angeles Gulch, a mile north of the Dunham tunnel, and south of this two additional shafts, 100 feet apart, were sunk to bedrock.

The property was never dredged, and from 1921 to 1932, the only activity consisted of drifting on a small scale.

In 1933, the Western Contracting Company worked one area for a few months with a power shovel, trucks, and stationary washing plant. 1,000 cubic yards were moved daily in an eight-hour shift, developing a large cut in the gravel with a face 40 feet high. The Igo Mining Corporation installed 7,000 feet of pipe, built a new reservoir, and for a few months in 1935 operated three hydraulic giants with nozzle openings of 4 to 5½ inches, under a head of 149 feet. The property has been idle since then.

The gravel on this property is said by Logan (1926, p. 187) to occupy three principal channels, the East, West, and Tom White, all trending south. Gravel in the channels and adjacent benches occupies a zone half to one mile wide, and ranges in thickness from 18 to 80 feet; large boulders locally are found next to bedrock. Bedrock consists of slate and tuff in the northern part of the property, Cretaceous sandstone in the southern part, and soft, decomposed quartz diorite in the remainder.

The best values in the gravel are near bedrock. Crawford (1894, p. 246) noted 10 feet of pay gravel in the Blue Bird mine; Brown (1916, p. 791) observed that the gravel contains "some pay" to a depth of 20 feet below the surface, but that the best values are within four feet of bedrock; and Tucker (1922, p. 599) reports that drifted gravel two feet above bedrock averaged $10 per yard in 1922. Gold is coarse, nuggets worth $2 and $3 having been found in 1931–1932, and is about 875 fine.

Gravel in the 12 shafts mentioned above averaged 12 cents per yard, and ran 32 cents per yard in the two

Photo 20. Bucketline dredge of the Thurman Gold Dredging Company on Clear Creek south of Redding, October 1943.

shafts south of Los Angeles Gulch. According to F. H. Russell (Averill 1933, p. 70), the entire prospecting program showed an average of 10⅓ cents per yard to an average depth of 45 feet; the area so valued is not reported, but probably was several hundred acres. Gravel worked by the Western Contracting Company in 1933, which came from a "particularly rich" channel, yielded 35 to 50 cents per yard.

Averill (1933, p. 70) reports that half of a block of ground 200 by 725 feet was removed from the old Dunham tunnel by room-and-pillar breasting 8 to 10 feet in height. Panning of the remaining pillars in 1932 indicated that the gravel removed (approximately 24,170 yards) had yielded $60,000 (about $2.50 per yard). Tucker (1922, p. 599) reports a total production from this property of $3,000,000 since 1865; although there are no data available from early operations, the extent of workings coupled with later sampling results tends to discredit this figure as being excessive. Nevertheless, production probably was substantial.

Thurman Gold Dredging Company. Location: Secs. 26 and 27, T. 31 N., R. 5 W., M.D., on Clear Creek about two miles west of Highway 99. Ownership: Thurman Gold Dredging Company, 625 Market Street, San Francisco, California, owns 720 acres.

The gravel at this site was 20 to 23 feet deep above a volcanic ash and clay "bedrock." There were few boulders, but many cobbles of quartz diorite, greenstone, rhyolite, and conglomerate were present. The pay channel was located by drilling churn-drill holes at 150-foot intervals, and the amount of gold recovered by the dredge checked the sampling closely. The Thurman Company operated here from December 1940 to April 1951, except for the interval October 1942 to July 1945 when gold mining was suspended by the government.

A Yuba dredge was built on 33 steel pontoons, making a hull 50 feet wide and 112 feet long. The digging ladder carried 69 buckets of nine-cubic-foot capacity, and could reach 35 feet below the water level. The gold was captured in sluice boxes fitted with Hungarian riffles. In a year's operation 7 or 8 ounces of platinum-group metals were recovered.

All machinery and equipment on the dredge was operated by electric power. The dredge was operated 24 hours per day with a crew of 18 to 21 men, and dug an average of about 480 cubic yards per hour.

The dredge was shut down April 18, 1951, and was dismantled and shipped to South America.

IRON

Deposits containing magnetite crop out in several localities in Shasta County, principally along the contact between McCloud Limestone and intrusive mafic quartz diorite, extending from 10 to 24 miles north-northeast of Redding. These are contact-metamorphic deposits in which magnetite occurs 1) in irregular lenses at the contact, 2) replacing carbonate rock along bedding planes and joints, or 3) filling fractures in both the marble and the quartz diorite. The ore consists of magnetite with varying amounts of garnet and skarn, small amounts of quartz and calcite, and usually a little pyrite and chalcopyrite.

Only the Shasta Iron and California Consolidated deposits in Shasta County have yielded substantial quantities of iron ore, but there has been production from the Hirz Mountain and Iron Mountain deposits also.

A potential source of iron exists in the massive pyrite deposits at Iron Mountain. The Mountain Copper Company, Ltd., shipped pyrite to the San Francisco Bay area from 1907 to 1962. The pyrite was roasted for its sulfur content, and the calcine, containing about 52 percent iron, was stockpiled at their plant near Martinez. Its use as iron ore presently is limited to incorporation into low-heat portland cement.

Extensive tests as to the suitability of iron ore from the Shasta Iron and California Consolidated deposits for use in electric-furnace processing were conducted by the U. S. Bureau of Mines in 1946 and 1947. The principal results are presented herein under the description of the Shasta Iron Company group.

In California, iron ore is used principally as blast-furnace feed, a source of FeO for use in low-heat portland cement, lump ore in open-hearth steel furnaces, and ship ballast. Gay (1957) has summarized from various sources the physical and chemical specifications ordinarily required of iron ore destined for these uses.

For blast-furnace feed, iron ore should be crushed to minus-2 inches, with 70 percent passing a 1-inch screen and not more than 20 percent passing a ⅛-inch screen. The iron content of the ore should range from 50 to 55 percent, manganese 0.8 to 1.5 percent, and lime plus magnesia should be low. Maximum allowable proportions of other constituents are: silica plus alumina, 10 percent; phosphorus 0.18 percent; sulfur 0.10 percent; TiO_2 1.0 percent; water 10 percent; and combined copper, lead, zinc, arsenic, vanadium, chromium, and nickel, 0.05 percent.

Approximately 5 percent FeO is added to portland cement used in massive structures, in order to reduce the heat that normally results from the chemical action of the cement during hardening. In the San Francisco Bay area, roll scale and calcines from roasted pyrite generally are used for this purposes; if iron ore is used, it should contain 60 percent or more of iron.

Lump iron ore is used in open-hearth steel furnaces to supply oxygen needed for the oxidation of carbon, silicon, and phosphorus, and usually comprises less than 5 percent of the furnace charge. The ore should be in lumps eight to 12 inches in maximum size, one to two inches minimum size, and should be free of fines. It should contain 60 to 65 percent iron and maxima of 0.05 percent sulfur, 0.05 percent phosphorus, and 5 percent silica.

Iron ore used as ship ballast is used either in its natural state or as a component of heavy aggregate. It should be compact and hard and should contain 60 percent or more of iron. Chemical impurities, except those that might react with cement, are unimportant.

Hirz Mountain (Jennings group) area. Location: Secs. 5, 6, 7, and 8, T. 35 N., R. 3 W., M.D., on northeast slope of Hirz Mountain west of the McCloud River, about 23 miles north-northeast of Redding. Ownership: Southern Pacific Land Company, San Francisco, California, owns Section 7. Five claims in Section 8 are owned by Jim Francis and Victor Lang, of Redding, California.

Claims were first located here in 1903 by J. J. Jennings, who thought the area showed promise as a source of gold, silver, copper, and iron. A number of open cuts and short adits were dug on 11 claims within a few years, but there is no record of further work until 1944. In August and September of that year, the U. S. Geological Survey mapped the geology and conducted a magnetometer survey of an area near the corner common to Sections 5, 6, 7, and 8.

In 1957, the Forest Service completed a road from Highway 99 on the east side of Salt Creek to the McCloud River. The road runs through Sections 6, 7, and 8 at an elevation of about 1,250 feet, and passes about 400 feet east of the eastern mineralized area.

The Universal Iron and Development Company secured a lease on the deposits in Sections 7 and 8 from the owners in 1957, and W. B. Jones and Sons of Millville, California, built an access road about half a mile long from the U.S. Forest Service road to the deposit. Equipment used included two D-8 Caterpillar bulldozers, a grader, a power shovel with a ¾-yard bucket, and a 5-cubic-yard dump truck.

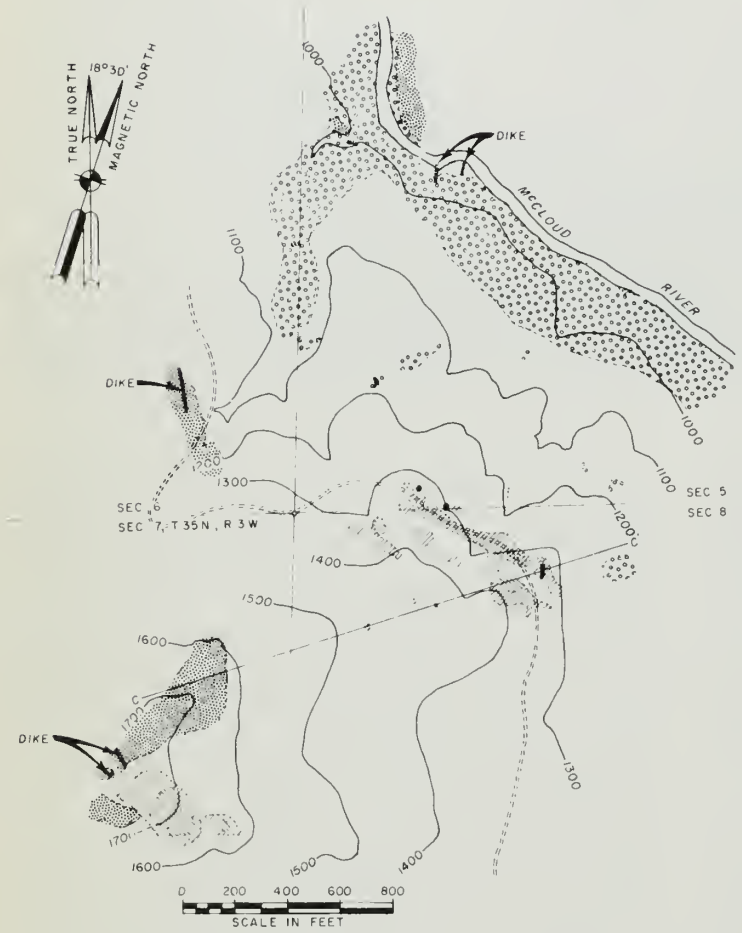
Exploration work consisted of stripping away the soft, tan-colored quartz diorite to expose the magnetite which crops out in places along the northeast slope of the mountain. In Section 8, a bulldozer cut was dug about 200 feet long in a N. 45° W. direction. It uncovered lenses of magnetite for lengths of 50, 25, and 20 feet and for widths of 10 to 20 feet. Other lenses of magnetite may be hidden under material that was washed down the hill by rain.

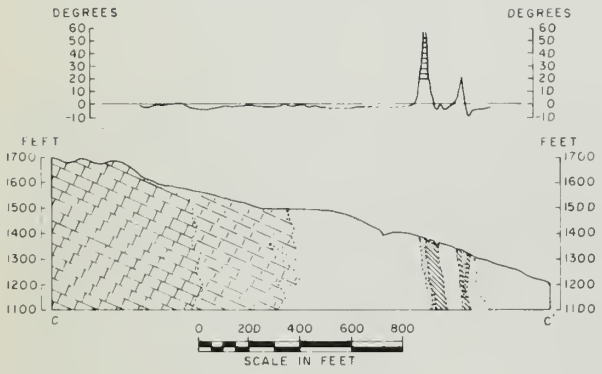
The property was idle during most of 1958, and the owners of the claims in Section 8 cancelled their lease with the Universal Iron and Development Corporation. In November 1958 the claim owners shipped two carloads of ore assaying 60.3 percent iron to the Pacific States Steel Corporation at Niles, California; the shipment amounted to 40 or 50 tons of ore. The ore reportedly was low in sulfur and phosphorus and included quite a little surface dirt that could be washed out.

During 1961 and the early part of 1962, Donald Clifton mined iron ore and sold it to Standard Slag Company under a contract the terms of which specified a minimum of 58 percent iron, a maximum of about 0.35 percent sulfur and a maximum of 40 percent fines (minus ¼ inch). Clifton reportedly experienced little difficulty meeting these requirements, but in January 1962 he was rejecting minus-½-inch material in order to upgrade the ore. Production during 1961 amounted to 3,335 long tons of ore containing slightly less than 60 percent iron, valued at $16,675.

By June 1962, Jim Francis and Victor Lang had acquired Clifton's interest in the property. No further production was reported by the middle of 1963.

Photo 21. Magnetite exposed in cut on Hirz Mountain iron deposit. View to north shows massive McCloud Limestone in background.





GEOLOGIC MAP EXPLANATION

QUATERNARY

Alluvium

JURASSIC CRETACEOUS

Quartz diorite dike.

PERMIAN

Exposed Nosoni formation. Pebbly and tuffaceous sediments interbedded with andesitic and basaltic flows

Exposed McCloud limestone; contains some chert.

ECONOMIC FEATURES

Exposed iron ore (magnetite and some hematite).

Covered area probably underlain by small bodies of iron ore near the surface, as indicated by magnetic attraction and a few trenches.

Covered area probably underlain by rocks containing small magnetite veins and some disseminated magnetite, as indicated by magnetic attraction

PROFILE EXPLANATION

McCloud limestone (Permian?). Contains some chert.

ECONOMIC FEATURES

Iron ore (magnetite and some hematite).

Iron ore and partly metamorposed Nosoni formation.

SYMBOL

Part of magnetic profile that probably indicates iron ore relatively near the surface; magnetic values higher than 20°.

Figure 7. Map and cross-section showing the general geology of the Hirz Mountain iron deposits.

The property is underlain by McCloud Limestone and tuffaceous sediments and basaltic and andesitic flows of the Nosoni Formation. These two units are separated by a north-northeast-trending fault in the northern third of the property and by an irregularly-shaped intrusive mass of mafic quartz diorite in the southern two-thirds. The Nosoni metasediments generally dip 30° to 60° NE, but one exposure of limestone dips 35° SE.

Poor exposures of magnetite and relatively weak magnetic anomalies found by the U. S. Geological Survey indicated two principal areas of iron mineralization about 1,200 feet apart in a northeasterly direction in the NE ¼ Section 7 and NW ¼ Section 8, at elevations of 1,700 and 1,300 feet, respectively; the eastern area is in Nosoni rocks and the other is in McCloud Limestone, on either side of and adjacent to the quartz diorite. Ore is chiefly magnetite with some hematite; it partially replaces the Nosoni and McCloud, and occurs as stringers and disseminations in both of these units and in the dike. Locally ore is accompanied by garnet and epidote. Locally, too, limestone is silicified and contains disseminated pyrite near its contact with the dike.

Part of a lens of massive magnetite in the open pit contains scattered yellow blebs of chalcopyrite and probably in addition a fine intergrowth or admixture of pyrite. Magnetite so affected does not separate from waste rock on a magnetic separator; it has a lower specific gravity than uncontaminated magnetite, is characterized by a faint pinkish cast to its black color, and emits a sulfurous odor in the crusher or when struck by a hammer.

A second magnetometer survey in 1961 or 1962 revealed a third area of potential ore, west of the open pit. According to Jim Francis (personal communication, June 1962), assays of ore from the three areas average 0.001 percent sulfur, slightly more P_2O_5, and 0.02 percent TiO_2.

Lamey (1948, p. 136) noted that there is "little likelihood of much ore being present near the surface unless dip needle values exceed +20° or are less than —20° over an area of considerable size". He estimated ore reserves of 260,000 tons per 100 feet of depth if one assumes that all areas yielding dip-needle values greater than +10° or less than —10° are underlain by minable ore, but pointed out that many of the small orebodies probably do not extend to a depth of even 100 feet. He concluded that reserves probably do not exceed a "few" hundred thousand tons.

Iron Mountain. Location: Sec. 34, T. 33 N., R. 6 W., M.D., 9½ airline miles northwest of Redding. Ownership: Mountain Copper Company of California, 100 Mococo Road, Martinez, California.

Since 1961 the Mountain Copper Company has intermittently mined magnetite from the northernmost of three small bodies of ore that crop out 400 to 800 feet southeast of the open pit resulting from the gossan-mining operation (see descriptions of gold and copper mining at Iron Mountain, herein). Approximately 13,000 tons were mined in 1961 for use in heavy aggregate for the Alameda Estuary tube, in the San Francisco Bay area. Intermittent mining in response to specific orders for magnetite continued until late 1962. Total magnetite production was 55,000 tons.

In September of that year, magnetite was being sent to an exporting firm for shipment to Japan. The base content of iron was set at 58 to 60 percent, with penalties or premiums being paid for lesser or greater proportions; 55 percent iron was the minimum acceptable grade. The rock was ripped or cut by bulldozer, and the magnetite selectively mined by power shovel. Occasional blasting was used on either of two benches, or for secondary breaking of large boulders of massive magnetite. The magnetite was crushed to minus-5 inches and shipped without further treatment.

Photo 22. Secondary blasting of magnetite boulders at Iron Mountain.

The surface outcrops of the three bodies of magnetite ore are situated in the medium-phenocryst unit of the Balaklala Rhyolite and trend northeast, but their subsurface shape has not been defined accurately; drilling seemed to suggest a mechanical mixture of metarhyolite and magnetite such as might have been produced by an extensive talus deposit. Ore reserves are estimated at about 200,000 tons.

The magnetite is massive, but is disseminated at the edges of the orebodies. Kinkel *et al.* (1956, p. 119) present a chemical analysis of a sample of magnetite that contained "some brown, rusty material" as follows: 20.63 percent FeO; 69.34 percent Fe_2O_3 (by calculation); 0.24 percent TiO_2. The sample contained about 70 percent magnetite, 10 percent hematite, and 20 percent limonite and gangue. Copper and zinc minerals are absent from the ore, and there is little or no pyrite.

Shasta Iron Company group. Location: Sec. 26, T. 34 N., R. 4 W., M.D., between Pit and McCloud arms of Shasta Reservoir about 13 miles north-northeast of Redding. Ownership: Shasta Iron Company, c/o Bunker Hill Iron Exploration, 620 Market Street, San Francisco 4, California.

The Shasta Iron Company owns 178 acres of patented land and six unpatented claims, and the California Consolidated Mines owns 88.6 acres of patented land adjoining and west of the Shasta Iron Company property.

The earliest history of this property is obscure. Lamey (1948a, p. 140) states that it was first mined as early as 1892, and Crawford (1894, p. 327) mentions a Maxwell group of five claims 1¾ miles east of the U. S. fish hatchery, possibly a reference to what later became the Maxwell claim of the California Consolidated Mines group. Two hundred tons of iron ore mined in Shasta County in 1894 probably came from this property. Diller (1903, p. 130), writing in 1902, is the first contemporary writer to specifically state that mining was in progress; he noted that iron ore used as a flux in the Bully Hill copper smelter was being mined from an open cut north of the Pit River. A year later, he wrote that the deposit had been opened to a width of 40 feet. The activity connected with Bully Hill was short lived, lasting only during 1901 and 1902.

In 1906, Aubury (p. 301) noted a "great number of openings" in Section 26; the largest opening, at an elevation of 1,650 feet just southeast of the "limestone knoll", was a quarry 40 feet wide and 15 feet deep, and was entirely in ore. He identified on a map the property of the Shasta Iron Company and the "California Consolidated Iron Mine".

The Noble Electric Steel Company built an electric-arc smelter nearby at Heroult in 1907 and began producing pig iron. Iron ore was obtained from the Shasta Iron property and was charged to the furnaces together with quartz, limestone, and charcoal. The smelter produced grades of iron ranging from No. 1 silicon (4.5 to 5.0 percent silicon) to foundry low (1.0 to 1.25 percent silicon); sulfur and phosphorus contents were very low. Daily production capacity in 1914 was 25 tons of pig iron, and 12 men were employed. Approximately 15,000 tons of ore were mined during the interval 1907 to 1914.

After World War I began, the smelter switched to production of ferromanganese and ferrosilicon. According to Logan (1926, p. 191), a typical charge for ferromanganese was 2,000 pounds of manganese ore, 800 pounds of limestone, 550 pounds of charcoal or coke, 60 pounds of fluorite, and 70 pounds of iron ore; the resulting product contained 12 to 20 percent iron. A typical charge for ferrosilicon was 2,000 pounds siliceous rock (85 percent silica, 5 to 10 percent iron), 1,000 pounds charcoal, and 400 pounds of iron ore (68 percent iron, 1 to 2 percent silica).

The smelter closed down after the war, but the steel company continued to mine ore intermittently from the Shasta Iron deposits until around 1920; then for several years prior to 1926, the deposits were worked continuously and 10 to 15 railroad cars of ore were shipped each month. Mining was carried on at two quarries during this time, and ore was moved to Heroult on the Sacramento Valley and Eastern Railroad line by a gravity tram 1,600 feet long. About 1,500 tons of ore from this operation were used in the manufacture of the high-tension electric transmission lines constructed from the Pit River southward. Ore mined from 1918 to 1925 was said to have contained 65 to 68 percent iron, 1 to 3½ percent silica, 0.02 percent sulfur, and 0.012 percent phosphorus (Logan, 1926, p. 192). In April 1925, Noble Electric Steel Company surrendered their lease on the Shasta Iron property.

The deposits were idle until 1942, when Lee Carrico and Melvin Gautier obtained a lease and began mining iron ore for shipment to naval shipyards, where it was used as ballast and heavy concrete aggregate for explosive mine anchors. Ore was selectively mined from two quarries 1,000 feet apart in a northeasterly direction, one each on the properties of Shasta Iron Company and California Consolidated Mines. Vertical blasting holes in the quarry benches were drilled by hand-held jackhammers to depths of 10 and 16 feet, on 4- by 6-foot and 7- by 8-foot centers, respectively. Large boulders of magnetite were broken by drilling and secondary blasting. Some ore and much of the waste rock were broken by a mechanical "rooter". Four power shovels with capacities of ⅜ to 1¼ cubic yards were used to load carefully-selected, high-grade

Phata 23. View af the northeasternmost pits in the Shasta Iron depasit. View to the southwest shows the Pit River bridge and McCloud River arm of Shasta Reservoir in the background.

Phata 24. Open pit in Shasta Iran depasit. Carrico and Gautier aperation, May 1944.

ore into trucks; two men were assigned to each shovel for the purpose of hand-sorting broken ore that was too intimately mixed with waste to be separated by the shovel operators.

Ore was trucked to Redding where it was crushed, screened, and washed at the J. H. Hein gravel plant. After water backing up behind Shasta Dam prevented the ore trucks from having access to U.S. Highway 99 from the quarries, they were moved across the new reservoir by barges of the U. S. Reclamation Service. As many as 42 men were employed during this time.

Activity ceased early in 1946. Production of iron ore for each of the five years of operation, beginning with 1942, was as follows: 18,000 tons; 102,979 tons; 105,656 tons; 70,059 tons; and 7,751 tons (Shattuck and Ricker, 1948, p. 3). From the beginning of this activity until July 1, 1944, 1,220,000 short tons of rock were moved in order to produce 162,000 short tons of ore containing 62 percent iron (Shattuck and Ricker, 1948, p. 5).

During March to September of 1944, the U. S. Bureau of Mines drilled five diamond-drill holes 300 to 800 feet deep and totaling about 2,900 feet, and the U. S. Geological Survey prepared magnetic-anomaly and geological maps; this exploration was conducted on both the Shasta Iron and California Consolidated properties (Lamey, 1948a; Shattuck and Ricker, 1948).

Metallurgical tests conducted on ore from these properties are reported by Shattuck and Ricker (1948, p. 10–11). The iron mineral was principally magnetite; recovery by magnetic separation was not affected by preliminary roasting, and better sulfur rejection was obtained on unroasted ore. In the table below, column A is an assay of a representative sample of the ore heads. Material represented by the assay in column B was obtained from unroasted ore by combined sink-float separation, jigging, and tabling, with the gravity concentrates representing 87.9 percent recovery of the iron. The concentrates were then crushed to minus-¼ inch and sintered with 4 percent by weight of coke; the assay of this material appears in column C. Column D shows an assay of unroasted ore that was ground to minus-100 mesh and separated by wet magnetic methods, with an iron recovery of 88.4 percent.

	A	B	C	D
Fe	40.0%	52.6%	53.8%	67.65%
insoluble	35.0	----------	17.8	4.4
SiO_2	18.6	11.4	11.4	
Al_2O_3	5.0			
MgO	2.3			
CaO	10.9	----------	6.8	
S	0.3	0.22	0.03	0.07
P	0.02	----------	<0.01	0.01
TiO_2	0.10			

At Shasta Dam in 1946, the U. S. Bureau of Mines built an electric-arc furnace with a capacity of 4 tons, in order to test the suitability of certain iron deposits —among them those of the Shasta Iron and California Consolidated properties—for the production of steel by other than the standard blast-furnace methods (Stephens and Morning, 1949).

1,000 tons of iron ore were shipped to the U. S. Bureau of Mines sponge-iron plant at Laramie, Wyoming, and the resulting sponge was used in the tests at Shasta Dam. The table below shows an assay of the ore sent to Laramie, and the range of assays of four lots of briquetted sponge iron (Stephens and Morning, 1949, p. 8):

Stephens and Morning found that carbon and alloy steels of excellent quality could be made from sponge iron, but that charging the furnace with sponge iron, compared to using prepared scrap, increased the cost of steel by $3.17 to $3.95 per net ton tapped; the charges of briquetted sponge contained 87.4 to 89.3 percent total iron that was 83.2 to 90.9 percent reduced. Steel

	Ore	Sponge
Fe	60.57%	85.3 –89.3%
metallic iron	----	70.7 –81.2
carbon	----	0.50 – 0.78
Mn	0.15	0.10 – 0.14
S	0.34	0.053– 0.103
P	0.013	0.009– 0.019
SiO_2	5.50	2.68 – 3.43
Al_2O_3	2.28	0.8 – 1.2
CaO	3.0	1.25 – 2.1
MgO	----	0.4 –– .65
reduction	----	82.7 –90.9%

made from the sponge had only very small proportions of residual or tramp alloying elements, in contrast to the relatively high proportions of such elements in steel made from scrap. Sponge iron from the Shasta Iron and California Consolidated ore contained 3.7 to 12.8 percent gangue, and it was found that operating difficulties increased with increasing content of gangue and iron oxide. Finally, it was found that briquetted-sponge iron was easier to handle than was the granular-sponge type.

The experimental plant produced more than 175 tons of steel and other ferro-alloys before closing down in 1947. It was moved to Pittsburgh, Pennsylvania, in 1954.

On May 10, 1948, litigation between the United States Government and Shasta Iron Company, California Consolidated Mines, and Carrico and Gautier over damage to the iron deposits by the waters of Shasta Reservoir was settled. The mining firms had sought damages totaling $1,450,000, but were awarded $300,-500, $100,325, and $7,000 respectively.

That same year, according to T. E. Gay, Jr. (1957, p. 255), an unspecified amount of iron ore was mined from the deposits for use in heavy aggregate; it contained a minimum of 58 percent iron, had a specific gravity of not less than 4.5, and was valued at $8.00 per ton f.o.b. railroad cars, Redding.

In March 1952, Gideon I. Dumond, president of Yolo Steel and Metal Company, announced plans to negotiate for construction of a blast-furnace iron smelter near Sacramento that would utilize ore from the Shasta Iron Company deposits (Sacramento Bee, March 6, 1952). Application by the company for a certificate of necessity, which would have permitted a rapid tax write-off, was denied the following month by the U. S. Office of Defense Mobilization, because of lack of evidence of an assured supply of iron ore and coking coal. A certificate of necessity was issued to the company for an electrolytic tinplate mill near Sacramento, however, on June 30, 1953.

In September of that year, Dumond announced that a concentrating plant was to be built at the site of the iron deposits, with construction to start within 90 days; nothing, however, came of these plans. In the spring of 1954, Mt. Shasta Steel and Tube Company was incorporated in Nevada with G. I. Dumond as president, and the new company began core drilling the Shasta Iron and California Consolidated deposits in May. By the following November, drill holes had been put down to depths of 500 feet, and some ore was shipped for testing purposes.

In December 1954, Fontaine Johnston, the secretary of Mt. Shasta Steel, announced that a steel mill and smelter would be established in Shasta County. By July 1955, the company had been reorganized and Dumond was a general partner in Lake Iron Ore Company, which was to handle the mining portion of the venture while Mt. Shasta Steel and Tube Company handled the smelting and milling. On July 8, 1955, Mt. Shasta Steel announced plans to issue $100,000,000 in stock at $25 a share, pending approval of the various governmental agencies involved (Redding Record-Searchlight, July 8, 1955). In August and September of that year, Dumond announced the purchase of 1,240 acres of land near Project City, where a hoped-for smelting and milling plant valued at $160,000,000 was to be built. A year later, in August 1956, it was announced that financing of the plant was being studied by East Coast interests. These plans never reached fruition, but Dumond retained his interests in the Shasta Iron and California Consolidated properties until 1957 or 1958.

During the spring of 1961, Ironex Company began drilling the iron deposits. This firm, a joint venture of Morrison-Knudsen, Bunker Hill Company, W. R.

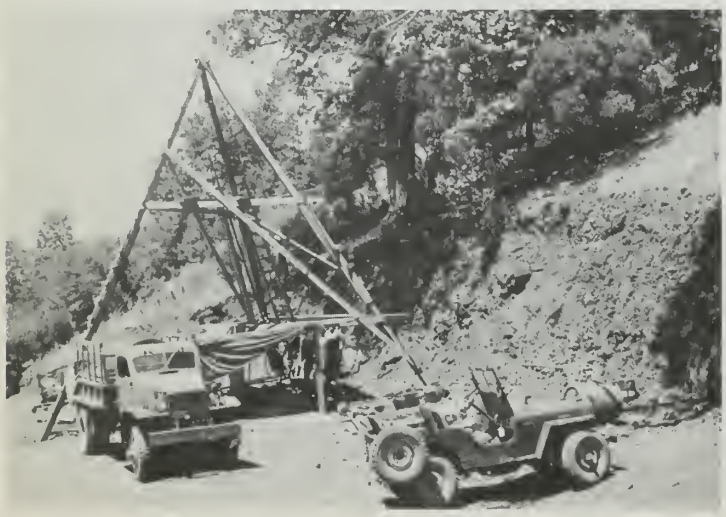


Photo 25. A crew from Morrison-Knudsen Company diomond-drilling hole no. 4 for Ironex on the Shasta Iron deposit, June 1954.

Grace & Company, and Hydro Carbon Research Corporation, by early 1962 completed a magnetometer survey more comprehensive than that of Lamey (1948a). About 12,000 feet of core holes along northwest-trending lines spaced 200 feet apart were drilled. Plans of the company called for mining from an open pit measuring 2,600 by 1,000 feet in maximum dimensions, with a depth near the level of Shasta Lake; tailings from a concentrating plant were to be stored on the property. Ore was to be wet-crushed and -screened, loaded into railroad cars, and barged 14 cars at a time across the McCloud arm of Shasta Lake by the U. S. Bureau of Reclamation, to a point near the north end of the Pit River bridge. The cars were to be raised to a siding at the elevation of the Southern Pacific railroad tracks by winch. Approximately 100 men were to be employed.

The core-drilling program reportedly blocked out reserves of about 20 million tons of ore; production was scheduled at a rate of 700,000 tons annually for the first five years and 500,000 tons annually for the next ten years (San Francisco Examiner, January 13, 1963). Various newspaper reports placed the anticipated cost of the concentrating plant at five to 15 million dollars. The ore was to be shipped to Japanese markets.

Shortly thereafter, new discoveries of iron ore in Australia made the Ironex proposal economically unattractive, and the project was "shelved".

The ore zone trends northeast between mafic quartz diorite on the southeast and McCloud Limestone on the northwest. The quartz diorite consists of fine- to coarse-grained varieties; the coarse type ranges from a light gray rock with white plagioclase and green ferromagnesian minerals to a dark gray rock with greenish, altered plagioclase and dark green or black ferromagnesian minerals. Near its contact with the quartz diorite, the McCloud Limestone is extensively metamorphosed to coarsely-crystalline, nearly-white marble; occasional chert lenses and nodules have been recrystallized to granular quartz. Calc-silicate rock developed in the marble consists of varying proportions of calcite and diopside-hedenbergite, with minor amounts of garnet, epidote, and amphibolite.

A dioritic rock exposed north of the ore zone is a dark gray, fine-grained rock that appears to have been intruded after the quartz diorite. Dikes composed of fine-grained diorite, diabase, andesite, and aplite cut the other rock types.

Steeply dipping joints, shear zones, faults, and dikes form zones of dominantly northeast and northwest structures. The structure of the bedded rocks is difficult to determine, but nearby limestone strikes northwest and dips 45° to 60° NE. Some major faulting of orebodies was detected in drill cores obtained by the Ironex Company, but was not of a magnitude sufficient to affect continuity of the ore. Evidence of faulting is abundant in the southwesternmost of the open pits; ore and skarn here show ubiquitous slickensides, and much of it easily breaks into small pieces.

Ore occurs in irregular lenses most of which are very discontinuous along both strike and dip; Lamey (1954a, p. 149) notes that "drilling and magnetic work show that good ore may be succeeded by very poor material within a few feet." The lenses are somewhat scattered and range up to 100 feet in length and 20 feet in thickness (U. S. Bureau of Mines, 1943, p. 3).

The contact-metamorphic rock in which the ore occurs contains garnet composed of nearly 100 percent of the andradite end-member, and pyroxene that forms radial masses up to a foot in length and is a member of the diopside-hedenbergite series containing about 50 percent hedenbergite (Lamey, 1961). Pyroxene apparently was formed first, followed in turn by garnet, amphibole (actinolite, anthophyllite, and tremolite), magnetite, ilvaite, and veins containing calcite, pyrite, or chalcopyrite, together or separately. Other minerals present include chlorite, epidote, sphene, and probably pyrrhotite.

The ore is chiefly magnetite, much of it being lodestone, together with moderately abundant hematite and geothite and subordinate to rare specularite. It occurs closely associated with serpentine (dominantly antigorite), which commonly is found above the orebodies.

Published chemical analyses of the ore indicate considerable variation in its character. Diller (1904, p. 178) quotes Mr. Keating, general superintendent of the Bully Hill mine, as stating that iron ore used as a flux in the smelter in 1901–1902 contained 70 percent iron, 1 or 2 percent insoluble, and a trace of sulfur. The first detailed published analysis was that of an "average sample of a several hundred ton shipment from the main property" (Prescott, 1908, p. 472), which was as follows:

Fe_3O_4	89.4%	MgO	0.3 %
Fe_2O_3	7.5	SiO_2	2.4
MnO	0.18	P	0.011
CaO	0.00	S	0.009
		Total	99.800%

The U. S. Bureau of Mines (1943, p. 4) published partial analyses of "clean ore" from the north (Shasta Iron Company) and south (California Consolidated Mines) pits being worked by Carrico and Gautier:

	north pit	south pit
Fe	71.31%	69.63%
insoluble	2.19	1.20
P	0.088	0.093
S	tr	tr

By far the most comprehensive published analyses are those of Shattuck and Ricker (1948), who published partial analyses of 10 chip and/or channel samples, more than 100 assays of core samples from four drill holes, and partial analyses of four composite samples from the cores. The drill-core assays were published again by Lamey (1948a) together with a detailed descriptive log of the cores. He calls attention to the variable nature of the chemical composition of

the ore, and presented the following data (1948a, p. 153):

	range of analyzed samples, in percent
Fe	4.00 –63.98
SiO_2	5.69 –31.62
S	0.010– 1.840
P	0.001– 0.027
Mn	0.19 – 0.67

The average iron content of 428 feet of drill core was 37.82 percent, which, according to Lamey, "probably is close to the average content of the ore". Lamey estimates that the iron ore deposits contain 187,000 tons of material averaging 62.99 percent iron; if lower cut-off grades are used for calculation, the deposits contain 1,849,000 tons averaging 39.5 percent iron, or 4,680,000 tons averaging 37.82 percent iron (1948a, p. 153).

LEAD

The lead produced in Shasta County has been recovered as a by-product from smelting silver and zinc-copper ores. Galena is present in minor proportions with gold in some quartz veins in the County, but there is no record of production from such ores. The occurrence of galena has been noted most frequently in the zinc-copper deposits and prospects of the Ingot district, 25 to 30 miles east of Redding. The zinc-copper ore mined at the Afterthought mine yielded more than 3,170 tons of lead metal, making that mine the chief source of lead in the County. Other mines in the area, such as the Davidson, Highgrade, and Silver Fern, have shipped small amounts of ore or concentrates containing 5.2 to 6.8 percent lead.

The Iron Mountain deposits have yielded about 150,000 pounds of lead, and slag and flue dust from the Mammoth smelter shipped in recent years were found to contain between eight and 13 percent lead. The Climax mine north of Igo shipped a small amount of ore during the 1920's that contained 6.6 percent lead.

The first statistics of lead production in Shasta County were recorded in 1910, but much lead must have been recovered in smelting the silver ores of the South Fork district at a much earlier date. The total production of lead in Shasta County, 1910 to 1962, not accounting for several years in which the amount was unapportioned, amounts to 8,195,997 pounds valued at $1,048,692. The peak was reached in 1947 when 1,634,000 pounds valued at $235,296 were produced. There has been little lead produced since the Afterthought mine closed down in August 1952.

MANGANESE

Manganese deposits in Shasta County can be classified into four types (Trask, 1943, p. 88): "(A) replaced siliceous porphyry adjacent to a mass of red jasper (Shasta Copper Company deposit); (B) manganese oxide in thin-bedded metamorphosed chert, in which the primary mineral is probably rhodonite (Victor and Nigger Hill deposits); (C) rhodonite segregations in chert interbedded with greenstone (Goat Camp deposit); and (D) manganiferous chert associated with greenstone (Nicol deposit). All the ore bodies are small except those at the Shasta Copper Company and Nigger Hill mines."

Deposits in the County have yielded only a little more than 1,000 tons, most of which came from the Pit River Consolidated (Shasta Copper Company) property; it was leased by Noble Electric Steel Company during 1916–1917, and the ore was used in the manufacture of ferromanganese. The Nicol and Nigger Hill mines have produced a small amount of ore. Production of manganese in Shasta County has been limited to brief intervals during World Wars I and II.

MOLYBDENITE

Only one deposit in the County has received attention as a possible commercial source of molybdenum. Here, molybdenite is disseminated through an aplite dike in peridotite, about two miles west of Gibson. Although this was the source of small amounts of ore and concentrate in 1917 and 1918, it was too low in grade for continued profitable operation. It is described in the tabulated list.

PLATINUM

Metals of the platinum group, which include platinum, palladium, osmium, iridium, and ruthenium, are obtained principally as by-products from gold-placer mining operations. Production data for specific locales in Shasta County are scarce. Platinum-group metals have been obtained from Beegum Creek, Clear Creek near Horsetown and two miles west of Highway 99, Roaring River, Cottonwood Creek near Gas Point, and from the Sacramento River north of Redding. Some platinum and palladium also were recovered in refining the blister copper smelted from or mined at Iron Mountain. According to Bradley (1917, p. 40), this amounted to 1.320 ounces of platinum and 0.607 ounce of palladium per 100 tons of blister copper treated in 1912.

The production figures for platinum in Shasta County were published from 1917 to 1927 inclusive and amounted to 1,430 ounces valued at $189,161. The production figures from 1927 to 1951 are unapportioned. There has been no platinum production recorded since the last gold dredge, operating on Clear Creek, shut down in 1951.

Aubury (1906, p. 348) reports that black sand concentrates from the Gypsy mine in the Shasta district contained 8.29 ounces gold and 0.25 ounce platinum per ton; black sand from the Gem mine on the Sacramento River north of Redding contained 0.64 ounce gold and 0.28 ounce platinum per ton. On the Roaring River, the ratio of platinum to gold reportedly ranges from 1:20 to 1:30.

Only two analyses of platinum-group metals from Shasta County are available in the literature (Logan, 1918, p. 38, 109). Material from Cottonwood Creek contained 33 percent platinum, 50 percent iridium, and 17 percent osmiridium; that from Beegum Creek contained 13.5 to 20.0 percent platinum and 79.0 to 84.0 percent osmiridium.

PYRITE

Pyrite was mined by underground methods and open pit at Iron Mountain by the Mountain Copper Company of California, from 1907 to 1962. It occurs in massive lenses in the upper part of the middle unit of the Balaklala Rhyolite. The deposits range in size from a few thousand to several million tons containing 90 to 95 percent pyrite. The pyrite was shipped to the San Francisco Bay area, where it was roasted and the sulfur dioxide thereby expelled used in the manufacture of sulfuric acid. The acid is used in oil refining, the manufacture of phosphate fertilizers, and in many other industrial processes. California ranked second in the quantity of pyrite produced in the United States in 1961.

Iron Mountain (Brick Flat, Hornet, Richmond) mine. Location: Secs. 26, 27, 34, and 35, T. 33 N., R. 6 W., M.D., at Iron Mountain about nine airline miles northwest of Redding. Ownership: Mountain Copper Company of California, 100 Mococo Road, Martinez, California.

The Brick Flat, Richmond, and Hornet orebodies extend in a northeasterly direction for a total length of about 3,500 feet. Kinkel and Albers (1951, p. 11) believe that they were one continuous body of massive pyrite before they were separated by faulting. Although these deposits were mined separately and at different times, they all are generally considered part of the Iron Mountain mine.

The Hornet orebody lies at the northeastern end of the group. It is about 1,200 feet long and its width tapers from a maximum of about 250 feet at the western end to a narrow point on the east. It is about 400 feet thick and dips nearly vertically. The Hornet orebody was worked through adits and by room-and-pillar stoping. It was estimated that 70 percent of the ore was recovered (Kett, 1947, p. 142); a more recent estimate reduced this figure to 60 percent (C. W. McClung, 1965, personal communication). The deposit is now worked out and caved.

The Richmond orebody is about 400 feet southwest of the Hornet. It was mined through the Richmond adit which was driven west about 1,500 feet to the ore and thence in a southwesterly direction for about 1,500 feet. The adit was driven beneath the orebody and steep raises with manways were driven through the ore at about 120-foot intervals. Drifts were run to connect the raises at the top and bottom of the orebody. The lower drifts were called "scram" drifts. Short inclined raises about four by four feet in section were driven into the ore on alternate sides from the scram drifts at 12½-foot centers. Stopes were carried 65 feet wide, 100 feet long, and 80 to 120 feet high. The ore was drilled and blasted through these raises to the scram drifts and pulled by electric powered slushers to the ore passes. Pillars 20 to 30 feet wide were left to protect the raises at the end of stopes, and a shallow arched roof of ore was left to support the back.

The Brick Flat orebody is an extension of the Richmond orebody and is situated 300 feet higher in elevation and to the southwest of it. It is about 1,200 feet long, 250 feet wide, and 75 to 150 feet thick.

The Hornet mine was patented in August 1894 and was acquired by the Mountain Mines, Ltd. (predecessor in interest to the Mountain Copper Company), in September 1895. Diamond drilling indicated the presence of about 4 million tons of pyrite in the main orebody, with additional ore at higher elevations. The ore consisted of massive pyrite with a nominal amount of copper and practically no silver or gold.

The Richmond Extension was an upper extension of the Richmond section and not separated by faulting as is the Brick Flat section. The Complex is an upper section at the Richmond separate from the Richmond Extension as well as the Brick Flat. (C. W. McClung, 1965, personal communication).

Although there was at the time no market for pyrite, C. W. Fielding, who had been instrumental in the sale of the Iron Mountain properties to the Mountain Mines, Ltd., foresaw a use based on the manufacture

Photo 26. Drilling overburden of Brick Flat pyrite orebody at Iron Mountain, 1956.

Photo 27. Stripping overburden from Brick Flat pyrite orebody, Iron Mountain mine.

of sulfuric acid that would in turn be used in processing phosphate-bearing rock to produce superphosphate. He instigated a search for phosphate rock that resulted in the discovery of the western phosphate fields in Idaho, Wyoming, Utah, and Montana. A company (San Francisco Chemical Company) was organized to mine phosphate and a plant was built in Martinez at about the same time that the company's smelter was moved there from Keswick (1906–1907). Sales of chemical fertilizer never reached the magnitude envisioned by Fielding, but subsequently the increased demand of petroleum refineries in the San Francisco Bay Area for sulfuric acid developed a steady demand for pyrite.

Mining of pyrite from the Hornet orebody began late in 1907. Sulfuric acid made from this ore was used for both petroleum refining and processing of phosphate rock, although little appears in the literature regarding the latter operation. Tucker (1924, p. 424) notes that the fertilizer plant at Martinez was operated to "full capacity in 1920 and a gas purifier, bluestone, and pigments made". An article appearing in Mining World (November 1947, p. 66) states that "San Francisco Chemical Company, subsidiary of Mountain Copper, is shipping phosphate at the rate of 60,000 tons monthly from the Waterloo open pit mine at Montpelier, Idaho", and shortly thereafter Mineral Information Service (California Division of Mines, 1948, p. 9) noted that Shasta County pyrite was "used in the manufacture of sulphuric acid, and many tons are used each day to treat rock phosphate mined in Idaho and Wyoming . . .". In 1956, Mountain Copper Company, Ltd., sold a 50-percent interest in San Francisco Chemical Company to Stauffer Chemical Company for 2 million dollars (Mining Journal, July 20, 1962, p. 69). Total production of pyrite from the Hornet, Richmond, Richmond Extension and Complex orebodies was 5,227,000 tons.

The Richmond orebody was mined for its pyrite content between 1926 and 1956. In 1942, the Richmond Extension orebody was explored by diamond drilling and by the Richmond adit; complex copper-zinc ore as well as pyrite was mined from this body during the war years. Mining of cupriferous pyrite from the Richmond mine ceased in mid-1947. Diamond drilling in 1949 revealed the existence of the Brick Flat orebody 100 to 300 feet beneath the surface.

In 1953, the aerial tram that had moved the ore from the Hornet mine to the loading facilities at Matheson was extended about a mile to a point near the old Richmond mill. The tram contained 92 buckets of ¾-ton capacity and was capable of moving 50 tons of ore each hour. Its length after the extension was completed was 18,000 feet.

Around this time, underground workings in the Richmond orebody were encountering broken ore that was difficult to extract, and the company began planning its operations at the Brick Flat orebody. It was decided to mine the new orebody by open-pit methods; this permitted a higher recovery of ore than was possible by underground mining, and also eventually would bring within reach the unmined ore in the upper part of the Richmond, Richmond Extension, Complex, and Hornet orebodies.

A road 8,500 feet long was constructed from the pit site to the crusher and tram terminal in the first half of 1955, and stripping began in June of that year. Overburden was removed at the rate of 500,000 tons each month during the peak of operations. The first pyrite was mined in January 1956, after 2.5 million tons of waste had been stripped (Mining World, June

Phata 28. Inclined diamand-drill hole being drilled on Brick Flat pyrite orebody, Mountain Copper Campany af California. Open pit visible in background.

1958). One shift was worked each day, and time was divided between mining and stripping in the ratio of 1 to 2. By mid-1956, Mountain Copper's entire output of pyrite came from this pit, and underground activity in the Richmond ceased.

The old Richmond crushing plant was modernized in 1955–1956 to handle ore from Brick Flat, which was crushed in three stages to minus-¼ inch. The mill processed 400 tons of ore in 3¾ to six hours. Wear rates on the crushers were high because of the hardness of the ore.

Pyrite production since the end of World War II has averaged 100,000 tons per year. It was sold principally to Stauffer Chemical Company and General Chemical Company in the San Francisco Bay area. Production from the Brick Flat orebody amounted to

Photo 29. Pawer shovel loading pyrite in the Brick Flat open pit, Iran Mountoin mine.

Photo 30. Open pit in Brick Flat pyrite orebody, Iron Mountain mine.

Photo 31. Pyrite crushing ond screening plant of the Mountain Copper Compony ot the Richmond odit. Terminal of the tramline is visible in lower right of photograph.

about 600,000 tons of pyrite, and 9.5 million tons of waste were removed (D. K. Winsor, personal communication, September 1962).

In July 1962, mining of pyrite at Brick Flat ceased because by-product sulfur from Canada could be delivered to the San Francisco Bay area and processed at a lower cost than was possible for the pyrite. On December 11, the Board of Directors of Mountain Copper Company, Ltd., voted to close down the mine by mid-January 1963.

Phata 32. Aerial-tramway terminal of Mauntain Copper Campany at Keswick. View narth.

QUICKSILVER

Cinnabar and native mercury occur in vugs and seams in metarhyolite about 20 miles east of Redding. Prospecting with shallow shafts and short adits around the turn of the century failed to reveal a commercial deposit.

SILVER

Silver ore was discovered in the South Fork district west of Igo in 1856. In 1879, James Sallee, a miner from Colorado, assayed some of the gossan at Iron Mountain and found it to be rich in silver and gold. A silver boom started that lasted until copper ore was discovered at depth. The first copper smelter was built at Keswick in 1896 and practically all of the silver produced in the County since then has been recovered as a by-product of refining blister copper. A minor amount has been recovered in refining gold. The total production of silver in Shasta County, 1880 to 1965, with the exception of a few years in which the amount was unapportioned, amounts to $12,365,100.

Kinkel *et al.* (1956, p. 118) tabulate production data from the Iron Mountain mine, showing that the Old Mine gossan yielded more than 2.6 million tons of ore averaging 8.21 ounces of silver per ton, a total potential production of about 22 million ounces of silver. County production data (table 2), however, show that about $270,000 in silver were produced during the time the gossan was being mined (1929–1942). At the average price of silver then prevailing, about 40 cents per ounce, this amounts to about 675,000 ounces. The discrepancy of 21 million ounces between silver actually produced and that present in the gossan must represent unrecovered silver lost to tailings and, ultimately, to the Sacramento River.

Orebodies in the South Fork district occur in quartz veins that have formed in sets of parallel fractures in granodiorite. The silver-bearing mineral is freibergite (silver-bearing tetrahedrite) associated with galena; native silver is found in some veins. Lesser proportions of pyrite, sphalerite, and chalcopyrite are present in most deposits; gold generally was a minor constituent, but at one mine, the Ballou, the principal value was in gold. The Chicago mine, the most important in the district, was discovered in 1866. This mine was worked until the late 1890's, and its total production probably was about $500,000.

Big Dyke mine. Location: Secs. 18 and 19, T. 31 N., R. 6 W., M.D., about three miles northwest of Igo, northwest of the Silver Falls-Chicago Consolidated group. Ownership: C. H. and Laura Richter, Box 1250, Cottonwood Avenue, Redding, California, own one patented claim.

The Big Dyke deposit was discovered in 1866 and became the third largest producer in the district. Some of the ore was valued as high as $600 per ton, mostly in silver. The Big Dyke vein is one of a series of roughly parallel veins in grandiorite, and the only one on which development work was done. It is about three feet wide, strikes N. 55° E., and dips 78° to 88° southeast. The vein filling consists of a silica-cemented breccia of limonite-stained quartz and fragments of granodiorite, and is heavily mineralized with argentiferous tetrahedrite and galena, native silver, pyrite, sphalerite, and gold in minor proportions. The vein material along the footwall resembles a coarse-grained, tan-colored quartzite. The oxide zone extends between 20 and 50 feet in depth.

The principal development consists of workings on two levels from a single-compartment shaft 200 feet deep on the vein. On the 100-foot level, a drift was driven 165 feet northeast and 20 feet southwest. A crosscut adit, driven north 200 feet through coarse-grained granodiorite, intersected the vein on the 100 foot level, 100 feet northeast of the shaft. Some ore, stoped 30 feet above this level and shipped to the Mammoth smelter at Kennett, is said to have averaged 300 ounces of silver per ton (Tucker, 1922a, p. 319). A drift was driven 65 feet northeast from the shaft on the 150-foot level.

In June 1941, F. A. Richter reopened a caved adit that had been driven from southwest of the shaft for 240 feet northeast on the vein at an elevation 125 feet below the collar. Richter said that 75 tons of ore mined from a small stope above the 100-foot level in 1918 had yielded $5,000 in silver.

In September 1948, the Igo Mining Company reopened the 200-foot crosscut adit on the 100-foot level and shipped about 75 tons of sorted stope-filling material to the flotation mill at the Kanaka (Sunshine) gold mine west of Redding. The concentrate was hauled to the Selby smelter.

The mine has been idle since 1948, although it was leased to Sanders Brothers of Bakersfield in 1954.

Silver Falls-Chicago Consolidated group. Location: Secs. 17, 18, 19, and 20, T. 31 N., R. 6 W.,

M.D., about three miles northwest of Igo. Ownership: Bertha F. Johnstone of Redding, California, and others own eight patented and four unpatented claims; Claude Harris, 2198 Court Street, Redding, California, lessee.

The Silver Falls-Chicago Consolidated group was the most productive mine in the South Fork mining district. The Chicago claim, from which almost all production in the group originated, was located in May 1866 and remained active until the late 1890's. Its total production has been given by a number of authors as about $1,000,000; because this figure appears so often in the literature, its validity is discussed below.

This figure was first stated by Laizure (1921, p. 527), who wrote that the total production was "reported to have been approximately $1,000,000". He did not give the source of this information, but Tucker (1922a, p. 314) clarified the matter: "According to Mr. Alex Lester, who was the pioneer Wells Fargo agent at Igo during the entire period that the Chicago mine was an active producer, the output was approximately $1,000,000". A private consulting report written in 1922 made this same statement, but noted that the express office had been destroyed by fire and that all the shipping records were lost.

If the former agent was indeed employed by Wells Fargo during the entire period of activity of the Chicago mine, he must have been at least 70 years old at the time he gave his estimate to Laizure; this, together with the fact that he was recalling details of a long series of events that occurred between 25 and 55 years previously, should cause the estimate to be accepted with some reservation.

Further, Tucker (1922a, p. 313) states that production from the Chicago mine amounted to "over $100,000" from 1866 to 1881. Silver production for all of Shasta County between 1880 and 1895, inclusive (silver production from blister copper refining began in 1896), amounts to $508,091; most but not all of this came from the South Fork silver district, and it included production from the Big Dyke and White Star mines as well as the Chicago. Inasmuch as production from the Chicago mine was insignificant after the mid-1890's, it follows that the total yield of the mine during its entire period of activity must have been much less than a million dollars, and probably was only half that amount.

At the Silver Falls-Chicago mine, a series of roughly parallel quartz veins trend northeastward through a light gray, medium-grained quartz diorite. One set of veins strikes N. 45° E. and another set strikes N. 58° E. The dips of the veins are almost vertical near the surface but at depth change to an average of 75° to 80° southeast. The width of the veins ranges from less than a foot to eight feet. The silver-bearing minerals are argentiferous tetrahedrite (freibergite) and galena, associated with pyrite and sphalerite; chalcopyrite and gold are minor. In most veins, gangue is present on both walls. Enrichment has occurred at the intersections of veins that slightly converge upward. Oxidation was evident in the workings to depths of 10 to 50 feet.

Most of the ore was mined through the main shaft on the Chicago claim, which was sunk on the Chicago-Madison vein to a depth of 210 feet, and was the site of the earliest operations on the property. The vein was stoped to the surface for a length of 400 feet southwest from the shaft. High mining costs and a drop in the price of silver brought an end to this activity in the late 1890's.

A crosscut adit at the southwest end of the Chicago claim cut the Chicago-Madison vein at 50 feet. The vein was 12 inches to two feet wide in a drift driven 75 feet northeast. The ore was high in gold and was stoped to the surface. Samples taken from the face of the drift assayed $26.00 per ton in gold.

On the Richmond claim, which is adjacent to and southeast of the Madison claim, three shallow shafts, known as the Wright shafts, were sunk at intervals of 40 and 60 feet to explore a vein in which ore was exposed on the surface. Tucker (1922a, p. 316) reported, "Samples taken from ore in place along the strike of the vein between these shafts ran from 10 ozs. to 163 ozs. in silver per ton. The ore shoot is 120 feet long, average width 12 inches". A drift, driven from No. 1 shaft to No. 2, exposed a vein 10 inches to 2 feet wide. Sorted ore from these workings assayed as high as 400 ounces per ton.

In 1900, in the most extensive exploration effort on the property, and to drain some of the upper workings, a crosscut adit was driven north about 3,000 feet at an elevation of 1,400 feet, passing approximately 600 feet below the outcrop of the Chicago vein. This adit intersected 36 veins, most of which were little more than seams or fractures in the quartz diorite. The crosscut was extended 200 feet as a drift on the 27th vein intersected, but no ore was developed. Drifts were driven for short distances on several other veins, but ore was exposed only in the 28th vein.

Vein No. 28 was cut by the adit approximately 700 feet north and 250 feet east of the portal. A drift driven 225 feet northeast exposed an oreshoot 215 feet long and averaging 12 inches in width. Ore was stoped the full width of five feet between walls and 20 feet high above the drift.

Shipments of ore from this stope to the Mammoth smelter in February 1910 assayed 17.7 ounces of silver and $0.83 in gold (Tucker, 1922a, p. 317).

In April 1921, tests on ore from this mine indicated that a satisfactory recovery could be made by flotation. In 1922, the California Bi-Metallic Corporation of Santa Barbara took a lease on the property with an option to purchase. They did about 1,400 feet of exploration work but there is no record of ore having been produced.

In September 1954, the property was leased to Sanders Brothers of Bakersfield and some of the old workings were reopened for sampling. A new road was built to the property by other interests in 1961, but no mining was done.

White Star (Crystal) group. Location: Sec. 20, T. 31 N., R. 6 W., M.D., about two miles northwest of Igo. Ownership: Mrs. M. E. Hawe, Igo, California, owns four claims.

The Crystal, now known as the White Star, was discovered in 1886. On this property, two parallel veins about 160 feet apart in granodiorite strike northeast and dip 80 degrees southeast. As in most of the other deposits in this district, the principal ore mineral is argentiferous tetrahedrite associated with sphalerite and lesser proportions of pyrite and chalcopyrite; native silver is present. Gold, not abundant, is mostly associated with pyrite.

A crosscut adit driven N. 50° W. cut the veins 90 to 100 feet below the surface. The first vein, 150 feet from the portal, was explored by drifts driven 50 feet northeast and 35 feet southwest. The ore was stoped about 15 feet above the drifts. The vein is 12 inches to 3 feet wide.

The adit intersected a branch of this vein 14 feet beyond, and drifts were driven on it 60 feet northeast and 100 feet southwest. A raise in the southwest drift was run to the surface, and the ore was stoped to the surface. From a raise in the northeast drift, an intermediate drift 40 feet above the sill was driven 40 feet southwest to connect with a shaft from the surface. A 50-foot winze also was sunk from the northeast drift, and a 100-foot drift driven to the northeast exposed the intersection of the two branches of the vein. An oreshoot 60 feet long and two to five feet wide was stoped out of this zone. Ore from this stope, shipped to the Selby smelter on April 27, 1922, assayed 150 ounces of silver, 0.2 ounce of gold, 1.8 percent lead, and 13.3 percent zinc (Tucker, 1922a, p. 320). The second vein was intersected by the adit 330 feet from the portal but was not explored further.

The property was worked intermittently during the early 1920's by Albert Kingsbury, former owner, who shipped about $2,000 worth of ore to smelters. The ore averaged $10 to $50 per ton. The Igo Mining Company operated the mine under lease in 1949 and shipped about 35 tons of sorted ore to the Selby smelter.

The Sanders Brothers of Bakersfield leased the property in September 1954, but no production was reported. It was leased by Raymond Pearson and David Niehoff in February 1961; the old adit was cleaned out, and a large, shallow cut 150 feet east of the adit exposed a few narrow quartz veins in diorite and granodiorite, some of which carry sulfides. No production is known from this activity.

TUNGSTEN

The presence of scheelite has been noted in gold quartz veins in the Washington and St. Jude mines in the French Gulch district, the Buena Vista and Milton mines in the Lower Springs district, and the Ajax mine in the Whiskey Creek district. Except at the Milton mine, where a small production of tungsten concentrate was reported in 1955, no attempt has been made to recover scheelite from these properties. The mines are described in the gold sections of the text and tabulated list.

ZINC

Zinc was long recognized as a prominent constituent of numerous copper deposits in Shasta County, but it was troublesome to the copper smelters. As a result, orebodies high in zinc were left unmined prior to 1915. In that year, the General Electric Company built a small experimental electrolytic zinc plant at Winthrop and recovered 300 to 400 pounds of zinc per day. Some electrolytic zinc was recovered from the smelter fumes at Kennett in 1917–1918, and at Winthrop in 1918, from ore mined at the Afterthought and Bully Hill mines. The price of zinc declined from 14.2 cents per pound in 1915 to about seven cents per pound in 1919, and the electrolytic plants were closed down.

Early attempts to separate the zinc and copper minerals by selective flotation were unsuccessful. Copper concentrate at the Ingot plant in 1918, for example, carried 12 percent zinc, and the zinc concentrate carried 2.6 percent copper. The Shasta Zinc Company built a zinc oxide plant at Bully Hill which was operated from June to December 1922, when it was shut down because of a drop in the price of zinc oxide.

The California Zinc Company took over the operation of the Afterthought and Bully Hill mines in 1924. The smelter and zinc oxide plant at Bully Hill were shut down and the flotation plant remodeled to make a bulk sulfide concentrate which was shipped to Belgium for treatment. The price of zinc declined from 7.337 cents per pound in 1926 to 6.242 cents per pound in 1927, and it was no longer profitable to ship zinc concentrate to Belgium. All the zinc-copper mines in Shasta County were closed down by August of that year.

No further attempt was made to mine zinc until the government premium plan for increasing the output of strategic metals went into effect in 1942. The Mountain Copper Company built a 350-ton selective flotation plant near the portal of their Richmond adit in 1943, which was operated until June 30, 1947. The Coronado Copper and Zinc Company built a 100-ton flotation plant at Ingot in 1948 to treat the zinc-copper ore from the Afterthought mine. The operation of these plants is described in the copper section of this report.

The mines listed in the tabulated list for zinc have either been the source of zinc-bearing ores or are known to contain sphalerite associated with chalcopyrite or galena.

Nonmetallic Minerals

ASBESTOS

Deposits of both chrysotile and anthophyllite asbestos are found in the areas underlain by ultramafic rocks in northwestern Shasta County. They occur in steeply dipping shear zones, lenses, and pockets in serpentine or peridotite. Production has been sporadic and limited to small amounts of anthophyllite asbestos that were used in the manufacture of acid filters and fire-resistant paint.

Blas (Asbestos Empress) group. Location: Sec. 20, T. 37 N., R. 5 W., M.D., about five miles northwest of Gibson. Ownership: Blas Asbestos Corporation, c/o John Boito, 919 Michigan Avenue, San Jose, California, owns eight patented claims and 12 unpatented locations.

Lenticular deposits of cross-fiber chrysotile asbestos in serpentine and peridotite are exposed in several open cuts 15 to 25 feet wide, 80 to 225 feet long, and

12 to 14 feet deep. Asbestos seams in one trench strike N. 85° W. and dip steeply south. Some fiber is ⅜ inch long, but most of it is 1/20 to ¼ inch in length. The Johns-Manville Corporation drilled 2,000 feet of exploratory holes in 1950, but the amount of fiber in the cores was not enough to encourage further development at that time. The Blas Asbestos Corporation processed a few tons of the material in a small pilot plant located on the highway at Eagle Roost Point, but no commercial production is recorded.

Stock Asbestos (Loma Blanca Mines, Inc., Powhatan Mining Company). Location: Sec. 33, T. 38 N., R. 5 W., and Secs. 1, 2, 4, and 12, T. 37 N., R. 5 W., M.D., about three miles northwest of Sims. Ownership: Ida M. Bryant *et al.*, 17308 N. Ardmore Avenue, Bellflower, California, owns 17 claims and 1023 acres of patented land; leased to Powhatan Mining Company, Baltimore, Maryland.

Extensive outcrops of serpentine on these claims contain both anthophyllite and chrysotile asbestos. Anthophyllite, the only type produced thus far, occurs in numerous slip-fiber veins on the property, and also in the form of mass-fiber bodies resulting from contact metamorphism of the serpentine by intrusive granitic rocks. This mineral previously had been identified as tremolite, but X-ray studies show that it is anthophyllite (Salem Rice, Jan. 1964, pers. comm.). Slip-fiber veins are typically only a few inches wide, but some contain lenticular pockets of fiber 10 or more feet wide and up to 50 feet long. Such fiber is characteristically white, weak, and somewhat brittle. A noteworthy feature, however, is its acid resistance—about 1 percent—which is significantly lower than the resistance of fiber from other West Coast properties (J. C. KempvanEe, Jan. 1964, pers. comm.). This characteristic is tested by weighing the fiber, soaking it in acid of given strength for a standard length of time, and then reweighing to determine the amount that was dissolved in the acid. Thus, fiber rated at 1 percent is so resistant as to be almost chemically inert.

Two adits about 150 feet apart are on the property, and one of these penetrated fiber for 60 feet; the orientation of this body of fiber is not known (J. C. KempvanEe, pers. comm., 1964).

Although chrysotile deposits have not been seriously prospected on this large property, Brown (1916, pp. 752–755) illustrates and discusses promising outcrops of chrysotile-bearing serpentine.

The first production from this property amounted to 47 tons in 1913. The material was mostly anthophyllite and was valued at $25.00 per ton at the property. The fiber was shipped to an experimental plant in Oakland and used in the manufacture of a variety of products such as pipe covering, composition flooring, and plaster for stucco. In 1916, 145 tons of anthophyllite asbestos were shipped, and there was additional production during the period 1920 to 1924. In 1929, a carload containing more than 44 tons was shipped (J. C. KempvanEe, Jan. 1964, pers. comm.). The property was idle from 1929 until 1942, when the Powhatan Mining Company of Baltimore, Maryland, secured a five-year lease.

In 1948, the property was leased to the Loma Blanca Mines, Incorporated, Homer E. Fenn of Salinas, President. During the succeeding five years, this company mined about 200 tons of anthophyllite, but shipments probably amounted to only some 30 tons. The material was sacked and shipped to the Powhatan Mining Company in Baltimore, Maryland. Fenn stated that the sacked No. 1 grade material, containing as much as 30 percent moisture, was worth $250 per ton f.o.b. Dunsmuir; the No. 2 grade sold for $55 per ton at the highway.

In March 1954 the mine was again leased, this time for 35 years, to the Powhatan Mining Company. This company was intending to build a road to the property in 1964, following which drilling was to be undertaken in order to define the shape and orientation of the mass of fiber intersected for 60 feet in the adit.

A small processing plant consisting of a hammer mill, blowers, screens, and a cyclone is located south of Mears Creek about 1¼ miles southeast of the property, but has not been used in recent years.

Sylvester (Powmears) mine. Location: Sec. 1, T. 37 N., R. 5 W., M.D., on the north side of Mears Creek about five miles northwest of Sims. Ownership: Southern Pacific Land Company, San Francisco, California, leased to John L. Serna, Dersch Road, Anderson, California.

Anthophyllite asbestos occurring in serpentine on this property has been identified as tremolite by most previous workers. However, Wiebelt and Smith (1959, p. 26) stated that the asbestos is anthophyllite, and X-ray study of material from this deposit by the Division of Mines and Geology confirms this identification (Salem Rice, Jan. 1964, pers. comm.).

The deposits have been explored by three adits. No. 1 adit, now partially caved at the portal, followed a fissure in serpentine striking N. 15° W. and dipping 78° west. A vein of white anthophyllite asbestos 12 to 14 inches wide, with fibers parallel to the strike, followed along the hanging wall of the fissure.

Ray J. Sylvester obtained a lease on this property in 1943 and drove No. 2 adit 40 feet in a N. 25° W.

Photo 33. Adit portal at the Sylvester asbestos property, September 1947.

direction, at an elevation about 30 feet lower than No. 1 adit. A vein of tremolite asbestos 28 inches wide strikes N. 34° W. and crosses the floor of this adit about eight feet from the portal.

No. 3 adit, started about 12 feet west of No. 2 adit, was driven 88 feet in an average N. 29° W. direction. At about 35 feet from the portal, a vertical vein of tremolite asbestos 30 inches wide and striking N. 34° W. was cut and followed for 50 feet, where it narrowed to about eight inches in width. There are about six inches of hard green amphibole on both sides of the vein, between the soft fiber and the dark green serpentine walls.

The asbestos fiber was sacked as it was mined in the drift, but had to be resorted to segregate the longer fibers. In 1948, Sylvester shipped about 20 tons of fiber to the Powhatan Mining Company, Baltimore, Maryland.

In August 1951, the property was leased to this company, which drove No. 2 adit an additional 50 or 60 feet, and drove two short adits west of No. 3 adit. About 35 tons of fiber were stockpiled from this work and a few tons were shipped in 1951.

Sylvester obtained another lease on the property in 1954, and in succeeding years mined a few tons of material which were used in Redding in the manufacture of a fire-resistant paint marketed under the name "Syl-a-bestos". This paint has good durability and insulating qualities. It has been used by the U. S. Plywood and R. L. Smith Lumber Company plants in Shasta County, to reduce the obvious potential of disastrous fires.

BARITE

Barite has been mined intermittently from two deposits in Shasta County since 1919. Most of the material was mined during the early 1930's and in 1962–1965 from a deposit east of Castella owned by the Glidden Company. In the earlier phase of activity, barite was shipped to Oakland where it was blended with zinc sulfide and used in the manufacture of a white pigment called lithopone. Barite mined during the early 1960's was shipped to a mill at Sutter City for grinding and eventual use as a drilling mud in the gas fields of that area.

Prices paid for ore mined in California and delivered to northern California processing facilities ranged from $12 to $15 per ton during the early 1960's (Weber, 1963, p. 7). Average costs of extracting barite rock in California during this same period included royalties $0.50 to $1.00 per ton; mining, $3 to $5 per ton; and transportation, $5 per ton for the first 100 miles and $5 per ton for an additional 200 miles (Weber, 1963, p. 8).

Glidden (Loftus). Location: Secs. 18 and 19, T. 38 N., R. 3 W., M.D., on Girard Ridge about four miles east of Castella. Ownership: The Glidden Company, Cleveland, Ohio; leased by the Baroid Division National Lead Company, 111 Broadway, New York 6, New York.

Barite was discovered here by Charles Loftus in 1917, but for several years work on the property was limited to prospecting and shallow development. The property was sold to The Glidden Paint Company in 1926, and an eight-mile road from Castella was completed to the deposits in 1931. That same year, several thousand tons of barite rock were mined. The first 6,500 tons averaged almost 93% $BaSO_4$; the grade of all shipments ranged from 88% to 96% $BaSO_4$ (Averill, 1939, p. 115). It was used in the San Francisco Bay area for the manufacture of lithopone, a white pigment.

The property was idle subsequently until 1961, when it was leased by the Yuba Milling Division of Metals Disintegrating Company. It was sub-leased that year to a contractor from Redding, who did a small amount of work. During 1962, it was sub-leased to Al Rossi of Mt. Shasta, and several thousand tons of ore were mined from shallow open cuts by bulldozer, power shovel, and front-end loader. Ore was mined and stockpiled near Castella during the summer months; during the winter, when rain and snow renders the deposit inaccessible, the ore was trucked 170 miles to Sutter City. There it was crushed, ground, and bagged in a mill operated by Yuba Milling for use in drilling mud in the natural gas wells being drilled around Sutter Buttes. Early in 1963, the primary lease reportedly was transferred to the Baroid Division of National Lead Company, and Al Rossi for a time continued mining for this firm. The property was idle during the summer of 1963.

The barite occurs in association with metamorphosed tuff and siliceous sediments of the Kennett Formation. It is overlain by an horizon containing lenses of limestone, which is thought to be the top of the Kennett Formation (Weber 1963a).

Barite layers and interbedded sediments form a small domical structure at the crest of a southeast-trending spur of Girard Ridge. An upper barite layer is 1 to 4 feet thick and consists of nearly even proportions of thinly interlayered quartz and barite, giving the rock a banded appearance. This material has specific gravities of 2.90 to 3.98. A lower barite layer 5 to 8 feet thick consists almost entirely of barite, with only small proportions of quartz or other minerals. Except for one sample (sp. g. 2.96), specific gravities range from 3.65 to 4.44 and average 4.16 for 14 points or horizons sampled in the lower barite layer (Weber, 1963a).

Limits of barite masses in the lower layer do not appear to conform to the bedding of the host rock; their peripheries are crushed and broken, with interstices filled by a clay-like material. Two principal masses of dark gray, fetid, brittle barite have been mined from two cuts arranged in a north-south direction. Fuchite (chromium mica) occurs as crusts on bedding planes in one part of the workings. A small exposure of barite 25 feet east of the cuts was thought by the operator to be an extension of the northern mass. An exploratory cut about 500 feet west of the cuts exposed a small lens of dark barite.

Immediately northeast of the northern cut, barite and siliceous rock of the upper layer are interbedded in small bands a few millimeters to a few centimeters thick; barite in this layer appears to thin out rapidly to the northeast and east.

Barite rock being mined in 1962–1963 was required to have a minimum specific gravity of 4.2; such rock usually was soft and dark, whereas lesser-quality barite was lighter colored and significantly harder, probably because of admixture of silica. Some of the soft, dark rock, however, did not meet the 4.2 requirement, and consequently ore grade and limits were determined by periodic measurements of specific gravity during mining.

CLAY

Three deposits of clay in Shasta County, included in the accompanying tabulated list, have been worked at one time or another as a source of material for the manufacture of brick. The most important deposit was that of Holt and Gregg in Anderson; a brick plant there had a capacity of 40,000 bricks in seven hours. In 1907, this plant produced 4½ million bricks. It closed down in 1920, and there has been no production of brick in Shasta County since that date.

COAL

The principal occurrences of coal in Shasta County are found east of Redding in sedimentary rocks of the Montgomery Creek Formation. The Dakin and Luce properties in this area were worked in the 1870's, but the principal period of activity was during 1926–1929, when the Mt. Shasta Coal Company prospected much of the area between Round Mountain and Whitmore. This company in addition did exploration and development work in the Barnes, Dakin, and Luce mines. Coal was produced in Shasta County in 1924, 1926, and 1928, but the sources of this production are not reported in the literature.

Coal also has been explored by shallow workings in the vicinities of Beegum Creek in western Shasta County and Kosk Creek north of Big Bend.

A good quality of coal suitable for use as a fuel should have a suitable fuel ratio (the ratio of fixed carbon to volatile matter, which is high in anthracite and low in lignite), high heating value, low ash content (which reflects the quantity of silt, clay, silica, etc., contained in the coal), low moisture content, and high durability.

Some coals, such as the Buena Vista lignite in Amador County, contain substances that are more valuable when recovered than the fuel qualities of the coal. The lignite at Buena Vista contains montan wax, which, when extracted by a solvent and refined, is used in polishes, rubber, insulation, greases, adhesives, and other commodities. Lignitic coals elsewhere in the United States also have been experimentally processed to yield tars and light oils that ultimately are used in pipe coating, road surfacing, wood preservative, waterproofing material, and industrial chemicals.

There are few published analyses of coal in Shasta County, and probably all that were made were done with a view toward developing a source of fuel. Future exploration of coal in this area therefore should also consider the non-fuel applications, if any, for which it might be suited.

Barnes (Mt. Shasta Coal Company). Location: Sec. 4, T. 33 N., R. 1 W., M.D., about 3½ miles southwest of Round Mountain. Ownership: Arthur W. Dakin, Box 621, Tiburon, California.

The Mount Shasta Coal Company did considerable exploration work on the Barnes and adjacent coal deposits between 1926 and 1929. An adit was driven in the northeast quarter of Section 4, and an incline was put down through the coal. About 650 feet of drifts were driven, and several holes from 233 to 592 feet long were diamond drilled in adjacent sections. The thickness of the coal was found to range from 2.33 to 6.50 feet, but there were many shale and clay partings. The coal dips a few degrees to the northwest between a sandstone roof and a bluish-gray shale floor.

A sink-float test made by James A. Kelly on the coal mined from the development work showed that about 64 percent of the coal could be floated in a fluid having a specific gravity of 1.44. Kelly reported (Averill, 1939, p. 121) that the moisture of samples ranged from 10.46 to 12.55 percent, ash from 12.18 to 22.6 percent, fixed carbon from 33.5 to 34.39 percent, and volatile combustibles from 32.9 to 36.20 percent. The number of B.T.U. varied from 8.055 to 9.592. The development work was halted when production of oil and gas from Kettleman Hill increased in 1929.

DIATOMITE

Deposits of fresh-water diatomite, formed in late Tertiary (mostly late Pliocene) time, are prominently exposed in northeastern Shasta County near the junction of the Pit River and Hat Creek. These beds, though slightly warped, are essentially horizontal and are several hundred feet thick. They were deposited in lakes formed when volcanic flows dammed the rivers and creeks in that area. Later volcanic flows covered the deposits which subsequently were exposed when streams of the present-day drainage cut through the lava. The diatomite beds probably extend under some of the volcanic rocks adjacent to the rim of the Hat Creek-Pit River basin. The material varies in grade and color, but considerable tonnages of a

Photo 34. White diatomite exposed along northeast shore of Loke Britton in cuts along State Highway 89 ond the McCloud River Railroad.

compact white diatomite are exposed. The development of these deposits has been handicapped by their distance from markets which can be supplied by deposits less remote and of proven usefulness.

The Mount Shasta Silica Company located several groups of association placer claims in 1921 and 1922 along the Pit River about nine miles north of Burney. The diatomite was prospected by numerous short adits, shallow pits, and cuts, and many samples were taken to determine the character of these deposits. A grinding and screening plant was built, but only small quantities of diatomite were sold and used locally as insulating material.

Many of the claims originally owned by the Mount Shasta Silica Company lying north of the Pit River in T. 36 and 37 N., R. 2 and 3 E., are now held by the Dicalite Division of Great Lakes Carbon Corporation. Assessment work consists of bulldozer cuts each year

Photo 35. Outcrop of diatomite explored by adit, Highway 299 at Hat Creek, east of Burney.

and no commercial production has been reported. The McCloud River Railroad right-of-way runs through cuts on some of these deposits.

The principal uses of diatomite are for filtration aids and fillers, which accounted for about three-quarters of the diatomite consumed in the United States in 1962. Included among the 300 or more uses of diatomite are applications in insulation, abrasives, absorbents, carriers for insecticides, fireproofing, flatting agents for paint, pozzolanic additive for cement, and soil conditioners. Diatomite from Shasta County has been used only for insulation of commercial refrigerators and in the manufacture of lightweight concrete blocks.

The main factors controlling the suitability of a deposit for commercial use are the shapes of the diatoms, density, physical state of aggregation, presence of impurities (principally volcanic ash or clay), and overburden. Specialty uses may depend on other characteristics, such as chemical purity. Only the material of highest quality can be used in filter aids, and it must undergo a complex processing before being marketed; material unsuitable for filter aid uses is consumed in the other uses of diatomite, but if it is useful for only one or a very few minor applications, it is unlikely that it can support a large operation.

Little information on the quality of the Hat Creek-Pit River deposits has been published. Chemical analyses reported by Logan (1926, p. 166; see tabulated list) show wide variations in the principal oxides: silica ranges from approximately 81 to 96 percent, Fe_2O_3 from 0.7 to 2.2 percent, alumina from 1 to 8 percent, and lime from 0.1 to 2.3 percent. Six genera of diatoms have been identified (see tabulated list) from three sample locations, with *Melosira granulata* and *Stephanodiscus* being the most abundant. Flow rates of a standard solution passed through filter cake prepared from diatomite from five locations in this area were determined by Skinner *et al.* (1944, p. 43–47, 66–67), and are summarized below.

Sample	Location (Section, T.__N., R.__E., MDB&M.)	Flow rate* (cc./20 min.) and clarity**			
		Uncalcined		Calcined***	
		−100 mesh	−250 +325 mesh	0% NaCl	4% NaCl
1	SW¼18–37–3	94mF	109mF	106mG	275fP
2a	SW¼SE¼21–37–3	23vsG			
2b	ditto	31vsG	37vsG	52sF	
3a	NE¼NE¼20–36–4	78sE			
3b	ditto	83mE	84mG	65sF	147mfP
4	NE¼NE¼20–36–4 (0.2 mi. E of No. 3)	36vsE	47sG	63sF	141mfF
5	NE¼NE¼16–36–4	43sG	67sF	89mF	270fP

* Flow-rate classification indicated by lower-case letter after flow rate: f fast, mf medium-fast, m medium, s slow, vs very slow.
** Clarity indicated by capital letter after flow rate: E excellent, G good, F fair, P poor.
*** Minus-100 mesh diatomite calcined at 1,750°F, then sized to −250 +325 mesh.

GEMSTONES

In a broad sense, a "gemstone" is merely a naturally-occurring mineral or rock of unusual beauty that is relatively rare and durable. The term includes both precious and semi-precious stones. Material of this sort that is mined or collected for commercial sale can be classed as: "gem material", from which unflawed stones of at least a few carats in weight can be cut; "specimen" material, attractive and unusual enough to be valued by collectors; and "pound" material suitable for simple lapidary work.

Localities for 78 different minerals in Shasta County are listed by Murdoch and Webb (1956), and other localities, not included in this list, are known to local collectors. If reported, mineral material removed by lapidarists or collectors is recorded in the statistics of mineral production for the county; in 1961, however, only $5 worth of gemstones were reported, although the actual value of such material collected in Shasta County must have been many times this amount for that year and several years previously.

GRAPHITE

Only one property in Shasta County is known to contain graphite in more than minor amounts. Steeply-dipping, carbon-rich lenses of broken rock have been prospected near Cove Creek, east of Gray Rocks on the south shore of Shasta Lake (see tabulated list).

The value of graphite in a deposit depends on both the proportion of graphite in the rock being mined, and the size of individual graphite flakes. There has been no production of graphite in California since 1935.

LIMESTONE

Undeveloped reserves of high-calcium limestone in Shasta County are probably among the largest conveniently located to highways and railroads on the Pacific Coast. Except for the recently-established operation of the Calaveras Cement Company, however, the limestone mined to date has been limited to that needed for local use because of the distance to large centers of consumption. Small quarries were operated between 1896 and 1937 to supply flux for the several copper smelters operated at various times in the County. Kilns intermittently produced lime for agricultural and construction purposes earlier than 1893 and as recently as 1927.

The largest of these earlier operations was that of Holt and Gregg north of the present site of Shasta Dam. Limestone was quarried and burned in kilns as early as 1884. A new quarry was opened around 1900 and three new kilns were built. Broken limestone—used as flux in the copper smelters—and burned lime were produced for many years. The operation closed down in 1925.

The earliest investigation of the feasibility of manufacturing portland cement in Shasta County was made by the Shasta Cement Materials Association in 1924. The Association acquired control of 1,262 acres of land in T. 34 N., R. 4 W., M.D., which included a deposit of McCloud Limestone one and one-half miles long with an average width of three-fourths of a mile, and a deposit of shale in Sec. 16 estimated to contain 200,000,000 tons. The possibility of using coal from the Oak Run district and gypsum from the Bully Hill mine was considered in connection with plans for a cement plant. The decision to use cement manufactured at Permanente, Santa Clara County, for building Shasta Dam discouraged further plans for a cement plant in Shasta County at that time.

Construction of a cement plant by the Calaveras Cement Company Division of the Flintkote Company was started late in 1959, and the kiln was fired up two years later. The first shipments of cement were made in February 1962 and full-scale production was attained later that year.

During 1963, limestone was quarried from a deposit near the junction of U. S. Highway 299 and the Little Cow Creek road. It reportedly was used as aggregate in construction of a P.G.&E. dam being built on the Pit River near Montgomery Creek.

There are four principal belts of limestone in Shasta County, as noted in the section on Mineral Resources; production of some extent has been realized from each of these.

A number of chemical analyses of limestone from the various deposits in Shasta County are summarized in the tabulated list. These must be regarded as only the most general indications of the quality of the rock available from each deposit, however, because the samples may have been taken so as to avoid obvious contaminants (chert, schist, magnesium-rich patches), or because they may represent only small portions of the total deposit.

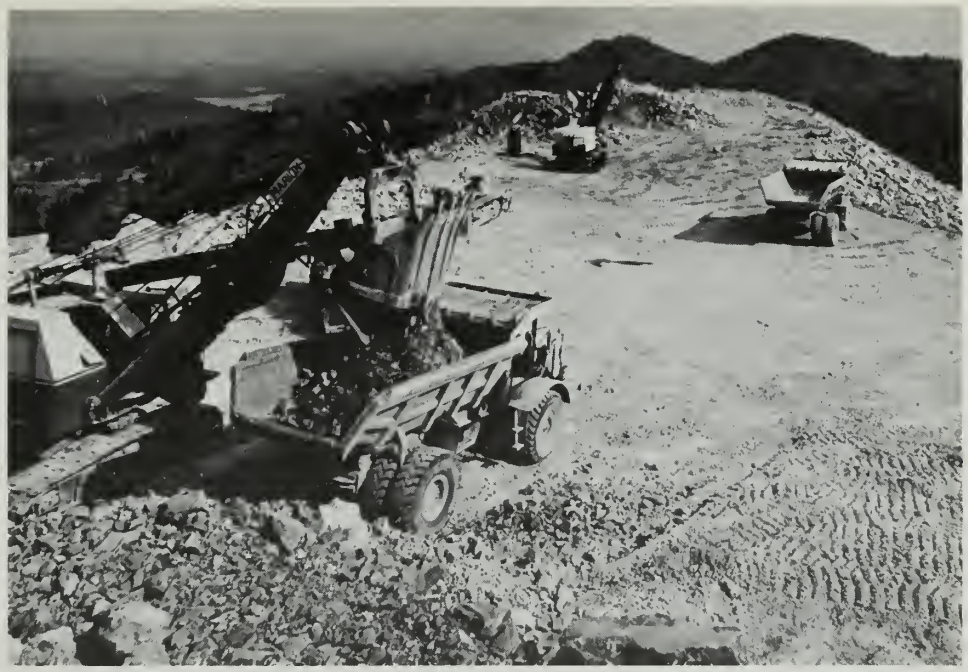
The McCloud Limestone is known to contain a few groups of large solution caverns, the better known of which are the Baird Caves in SW¼ SW¼ Section 13, T. 43 N., R. 4 W., east of the McCloud arm of Shasta Lake, and Potter Creek Caves in the adjoining Section 23. Both groups of caves were discovered by James A. Richardson in 1878, and have yielded fossil remains of Pleistocene mammals (Sinclair, 1904; Merriam, 1906).

Baird Caves were named after Professor Spencer E. Baird, who, as the first Federal fisheries commissioner, supervised construction of a salmon hatchery nearby in 1873. About 30 separate rooms or chambers on several levels are known. In 1960, a 40-acre tract including the caves was sold to Lake Shasta Properties, Incorporated. During the next three years, this firm drove about 500 feet of five- by seven-foot tunnel, installed stairs and electric lights, and built a parking lot at O'Brien on U. S. Highway 99. Access from O'Brien is by boat across Shasta Lake and then by bus to the cave entrance. The caves, now named Lake Shasta Caverns, were opened to the public in mid-1964.

Calaveras Cement Company. Location: Secs. 2, 3, 9, 10, and 11, T. 33 N., R. 4 W., M.D., about four to five miles north-northeast of Project City. Ownership: Calaveras Cement Company, Division of the Flintkote Company, 215 Montgomery Street, San Francisco, California. William Wallace Mein, Jr., President; James T. Curry, Plant Manager; Mitchell Becich, Quarry Superintendent; T. C. Slater, Geologist (c/o Kentucky House, Calaveras County).

Calaveras Cement Company began scouting locations in northern California for a cement plant in the early 1950's, and in 1957 began evaluating sites in Shasta County. Three diamond-drill holes were put down at Gray Rocks, including one about 500 feet deep, by the end of that year. Early in 1958 the company acquired 550 acres at Gray Rocks and by the end of the following year had purchased an additional 650 acres near Mountain Gate, some 12 miles north of Redding.

In September 1959, Calaveras Cement merged with the Flintkote Company, and two months later plans were announced for construction of a 15-million-dollar, dry-process cement plant. The first construction contract was let in May 1960 but before the plant was completed, a bulk distribution center was established at Springfield, Oregon, supplied by shipments from the Calaveras County plant of Calaveras Cement Company. The kiln of the Redding plant was fired in December 1961, and in February 1962, the first shipments of cement were made, simultaneously to a Redding firm and the Oregon distribution center. By April of that year, the production rate of the plant had reached 85 percent of its annual capacity of 1.5 million



Phato 36. Quarry of Calaveras Cement Company on Gray Racks. View east-northeast.

barrels of cement (one barrel contains four cubic feet or 376 pounds of cement).

The Redding plant, one of 13 cement plants currently active in the State, is the northernmost in California. The marketing area for its products includes all of Oregon and extends as far south as Marysville in California. Cement from this plant already has been used in a number of notable construction projects, including the Trinity Dam power plant, Lewiston fish hatchery, and the U. S. Highway 99 freeway between Anderson and Red Bluff.

The plant is largely automatic and requires a crew of only 80 men for round-the-clock operation during the week, and five to eight men on weekends. In all phases of the Calaveras Cement operation, including the quarry, a total of only 105 men is employed. Initial production is confined to portland cement Types I, II, III, Plastic, Early Hardening, and Pipe. Type I cement is a general purpose cement used in most construction work, where no special properties are required. Type II cement is used in the construction of large structures, such as dams or canals, where heat of hydration must be kept at moderate levels and some resistance to sulfate-bearing water is desired. Type III develops high early strength, Plastic cement is used for plaster and stucco work, and Pipe cement is used in the manufacture of concrete pipe.

Limestone employed in the manufacture of cement is obtained from a quarry on Gray Rocks, a mile northeast of and about 1,250 feet higher in elevation than the plant. Rock is blasted, broken by drop ball when necessary, loaded by three-cubic-yard power shovels onto 25-ton Euclid trucks, and moved 1,200 feet north to the primary crusher. The limestone is crushed to minus-5 inches and discharged down a 550-foot vertical shaft eight feet in diameter to a draw-pocket.

From there the rock is fed continuously onto a 36-inch rubber conveyor belt 7,540 feet long that moves it to a surge pile immediately north of the cement plant. The belt passes first through a 740-foot adit 10 feet in diameter, and then for the rest of its journey through an inverted-channel, covered, all-weather structure made of prestressed concrete slabs mounted on prestressed concrete piers. The belt consists of three sections meeting at two transfer houses. The largest section, weighing 60 tons, is notable for dropping a vertical distance of 513 feet in a horizontal distance of 4,400 feet, probably the most precipitous drop made by any large conveyor belt system in the United States. Downward movement of the belt is utilized to generate 185 kilowatts of power, which helps to operate the primary crusher. Ten tons of limestone are delivered to the surge pile each minute by the belt, which moves at a rate of five miles per hour.

Limestone is belt-fed from the surge pile to secondary and tertiary crushers that reduce the particle size of the rock first to two inches and then to ⅜-inch. It is then moved to large piles in the raw storage building.

"Shale", meanwhile, is quarried from an open pit half a mile southwest of the plant. It consists of clayey slates and altered metavolcanic rocks of the Bragdon and Kennett Formations and Bass Mountain Diabase. Shale is trucked to the plant, crushed, ground, and stored in the raw storage building along with the limestone. This building is able to store as much as 30,000 tons of limestone, 8,000 tons of shale, and 500 tons of iron ore.

Portland cement usually consists of a mixture of 75 percent calcium carbonate, 20 percent silica + alumina + iron oxide (obtained from "shale"), and 5 percent of other ingredients. In the Calaveras operation, limestone and shale are mixed in a ratio of 3 to 1.

The raw materials are moved by traveling crane from the storage bins to the raw grinding circuit where a ball mill 17 feet long and 13 feet in diameter —containing 120 tons of steel balls—reduces the rock to powder. From the mill, the powder is moved to a series of blending silos, where any desired final adjustments in the mix can be made. The raw material is dried during passage through the raw milling circuit.

It is these steps in the flow sheet that give the designation "dry process" to this method of cement manufacture. The majority of cement plants in the United States employ a wet process, in which a liquid slurry of water and ground raw materials is fed to the kiln. The dry process results in a lower rate of fuel consumption in the kiln because the feed is already dry, and permits a higher production capacity from the kiln than would be possible using a wet process.

At the feed end of the kiln is a bag house that collects dust emitted when the powdered raw material is placed in the kiln. It contains 1008 bags 25 feet tall, made of heavy glass fiber. Dust collected by the bags is automatically returned to the kiln.

The kiln itself is 425 feet long, has diameters of 13 feet 6 inches at the feed end and 12 feet at the discharge end, weighs 1,650 tons, and, powered by two 100-horsepower engines, completes one revolution every 51 seconds. At the feed end of the kiln, the interior temperature is 700°F. The blended material takes one and a half hours to pass through the kiln, which, at the burning end, attains an interior temperature of 2700°F. Clinker is discharged into a series of mechanical coolers that reduce the clinker temperature to 150°F. in 15 minutes, and then is transferred to a clinker-storage building with a capacity of 23,000 tons. The kiln produces approximately 760 tons of clinker daily. It originally used about 960 gallons of oil each hour as fuel, but since September 1962, natural gas has been used.

Clinker from storage is blended with about 5 percent of gypsum, and then is transferred by traveling cranes to finished-grinding ball mills that reduce it to a powder finer than face powder. The resulting cement powder is moved through pipes by air pressure to a series of storage silos at the pack house.

The pack house has facilities arranged so that bulk quantities of cement can be loaded simultaneously into railroad cars and trucks; the two weighing scales are automatic, and also can service railroad cars and trucks at the same time. An automatic bagging machine in the pack house is able to fill, weigh, and close 23 sacks of cement per minute, and drop them on a conveyor belt that moves them to a loading dock.

One of the unusual features of the cement plant is the central control room, where a control supervisor tends to an impressive bank of machines that automatically measure, continuously record, and regulate feed rates, temperatures, pressures, humidities, motor

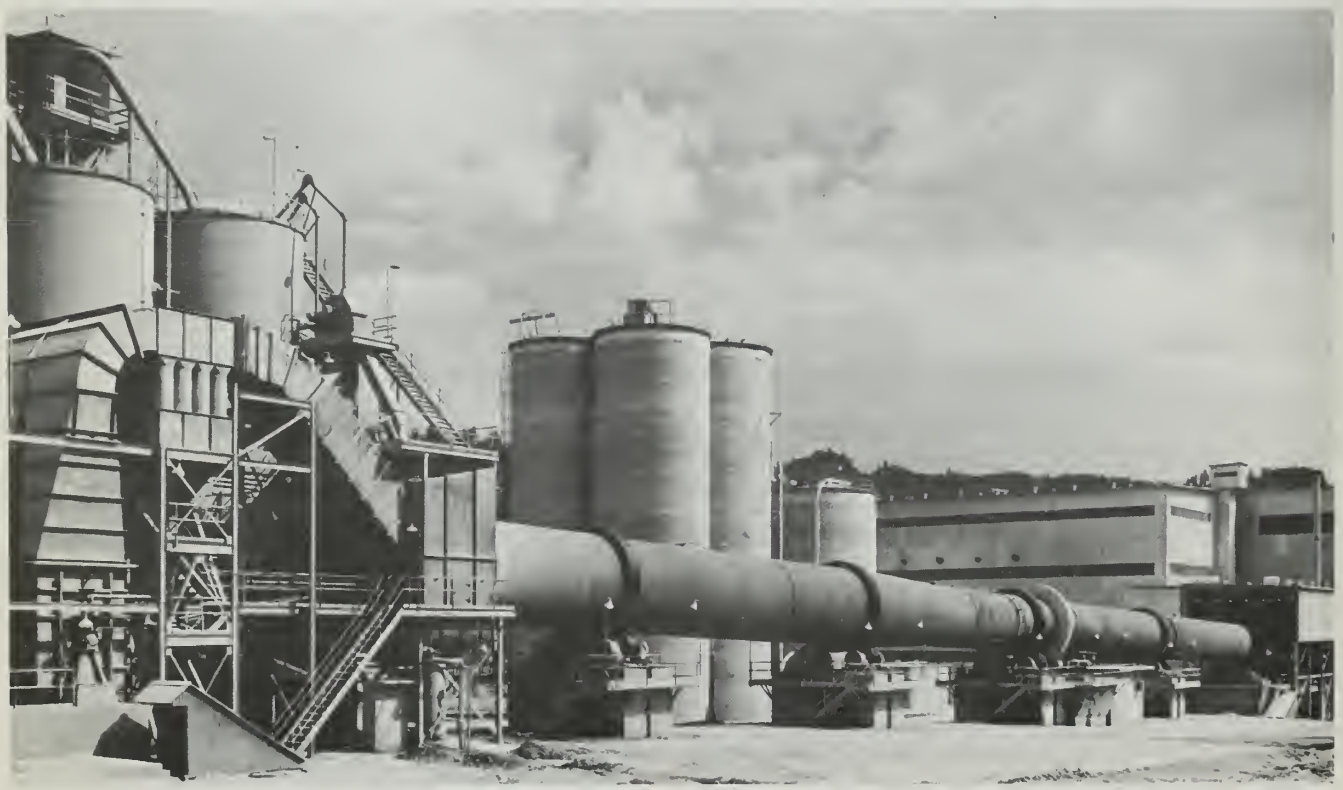


Photo 37. Kiln at cement plant of Calaveras Cement Company north of Redding. The kiln is 425 feet long and 13 feet 6 inches in diameter at the feed end, close to the viewer. The raw milling circuit and automatic cantrol system are housed in the building in back of the kiln.

Phata 37a. Aerial view ta the nartheast showing the plant and limestone quarry af Calaveras Cement Company narth of Redding.

amperages and voltages, material levels in bins, and a host of other processes and activities in the plant. Only the functionings of the quarry and pack house are not controlled from this room.

The quarry from which Calaveras Cement obtains limestone is situated in the McCloud Limestone of Permian age, on the south peak of Gray Rocks. The main deposit of limestone is oval shaped in plan, gently homoclinal with a southeasterly dip, and is approximately 2,000 feet long and 500 feet wide. Drill holes show that the base of the limestone is irregular, but averages about 400 feet in depth. Other, smaller masses of McCloud Limestone are scattered nearby, but the principal outcrops are distributed in an approximately straight line trending slightly east of north for three miles south of the quarry and, across Shasta Reservoir, for several miles to the north.

The McCloud Limestone throughout much of its extent is intruded by a younger igneous rock that appears to have disrupted the limestone in some areas (especially north of Shasta Reservoir), rotating adjacent blocks so that the projected beddings are now discordant with respect to each other. This intrusive rock, a mafic quartz diorite, has locally penetrated and altered the limestone, yielding coarsely crystalline marble or dense tactite. Irregular bodies of tactite in the vicinity of the Calaveras quarry had previously been explored as potential sources of iron or copper (see Black Diamond and Roseman mines in tabulated list under both copper and iron, and Jaegel and Memorial under copper).

At Gray Rocks, the limestone is a massive, fine-grained, light- to medium-gray rock. Portions of the limestone are characterized by patches that yield "elephant-skin" texture upon weathering, probably indicating a significant content of magnesium. North of the quarry is a zone of limestone containing numerous thin beds of white, fine-grained chert. A typical analysis of limestone from the Calaveras quarry has been reported by Bowen and Gray (1962) as follows:

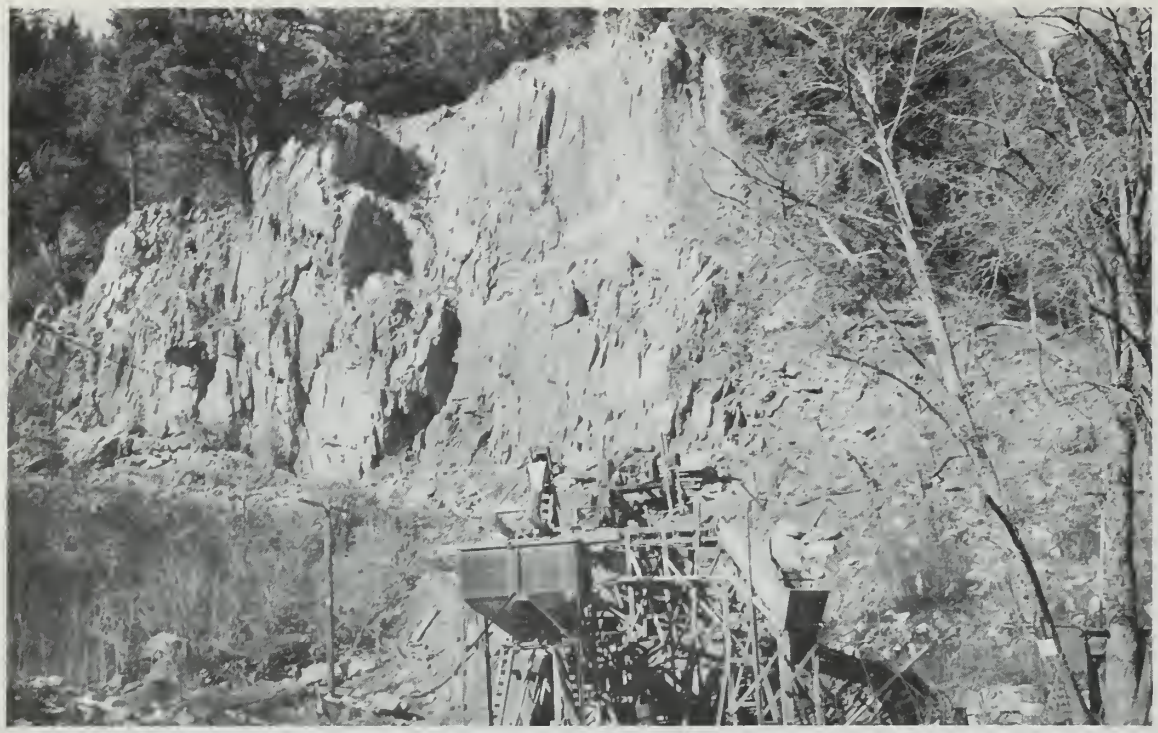


Photo 38. Crushing and screening plant of the Redding Lime Products Company at the Asher limestone quarry, January 1955.

CaO	54.35%*	Fe_2O_3	0.04%
MgO	0.77	P_2O_5	0.02
SiO_2	0.66	Ign. loss	43.92
Al_2O_3	0.26		

(*97.00% $CaCO_3$, using factor of 1.7847)

Evans (1969) describes the Gray Rocks area.

MINERAL SPRINGS

Shasta County has dozens, if not hundreds, of mineral springs, but only a few have had the combination of chemical character, size, and accessibility to have made feasible their commercial development; these are shown in the tabulated list. The last commercial development of a spring in this County was in 1955, when the Mountain Spring Water Company abandoned its spring near Montgomery Creek and began using water from a well near its plant.

Mountain Spring Water Company. Location: Sec. 6, T. 31 N., R. 4 W., M.D., about half a mile south of State Highway 44, just east of the Sacramento River. Ownership: Larry H. Tilden, 2610 Henderson Road, Redding, California.

This company, under the name Hilltop Spring Water Company, was organized in 1918 by A. F. Sarcletti and others. Water from a spring near the town of Shasta was used. In 1933, the company was sold to a Mr. Pearson. Ten years later, it was purchased by J. R. Herman, who developed a new source of water near Montgomery Creek and changed the name of the company to its present form.

This spring is situated 1.4 miles northeast of the town of Montgomery Creek, just west of the realigned route of U. S. Highway 299. Water issuing from between disoriented boulders of basalt was collected in a cedar box and passed through a thousand feet of pipe to a loading point on the old highway. A tank truck with a capacity of 2,650 gallons carried the water to the bottling plant in Redding.

Larry Tilden acquired the company in October 1950. In February 1955, a well was drilled near the bottling plant to serve as a new source of water, and use of the spring near Montgomery Creek was discontinued. Because of the high iron and manganese content encountered in the well water, the plant was expanded to include chlorination and filtration units.

Treatment of water in this plant consists essentially of removal of traces of minerals present in it, followed by removal of the materials used to remove the minerals, and addition of oxygen and carbon dioxide to improve the taste.

Water from the 76-foot cased well is first passed through a four-tray coke aerator that has the effect of adding oxygen. Chlorine, which reacts with the iron and manganese, is added in a small mixing tank, together with alum. The water then is moved to and upward through a 1,000-gallon tank where, during an interval of four to five hours, the reactions of oxidation and coagulation take place. Overflow from this tank passes by gravity to a 620-gallon storage tank.

From storage, water is moved under pressure through an Infilco sand filter, consisting of several alternating layers of sand and gravel encased in a unit 24 inches across and 55 inches high. This removes

the coagulated suspensions from the water. Once each week the unit is backflushed. The water next filters through an Hydrodarco Water Purifier containing 20 inches of granular activated carbon over layers of sand and gravel. Any residual traces of chlorine are thus removed, and the taste and color of the water are improved. The unit is backflushed daily, and the carbon is replaced annually. The last step in clarifying the water involves a water polisher, which removes traces of carbon powder introduced in the preceding step. This consists of a disc filter 16 inches in diameter, containing paper filters encased in felt. At this stage of its treatment, the water has a pH of about 7.0 or 7.1.

Final processing includes an ozone generator and a carbon-dioxide aerator. The ozone generator adds oxygen that gives the water a "lively" taste. In the aerator, carbon dioxide gas is passed through the water under low pressure, bringing the pH to about 6.8. This slight acidity controls potential growth of algae and imparts a pleasing, "sweet" taste. Water is then moved to a 500-gallon, finished-water storage tank, from which it is drawn as needed for bottling.

The capacity of the plant is about 300 gallons per hour. In addition to the treatment plant just described, there is an electrically-heated Stokes still that has a capacity of about three gallons per hour. Distilled water thus produced is held in a 60-gallon storage tank prior to bottling.

Quality of bottled drinking and distilled water is regulated by the State Department of Public Health and the Shasta County Health Department. Routine bacteriological and chemical sampling of the water is carried out by these agencies on a continuing basis. In general, the water must be free of coliform bacteria, contain less than 0.3 ppm (parts per million by weight) iron plus manganese, and meet other specifications as set forth in the "Regulations relating to bottled water" in the California Administrative Code, Title 17 (Public Health).

The following analyses made in 1957 by the California State Bureau of Sanitary Engineering show the changes effected by treatment of the water:

	Source of water	
	well	bottled
appearance	heavy brown precipitate	colorless
odor	none	none
Analysis, parts per million:		
total solids (gravimetric)	314	314
$CaCO_3$ hardness (calculated)	123	146
alkalinity as calcium bicarbonate	134.5	140.5
chlorides, Cl	50.5	38.3
sulfates, SO_4	13.8	21.1
fluorides, F	0.1	0.0
nitrates, NO_3	0.0	0.0
Ca	25.2	31.2
Fe	10.0	0.0
Mg	24.6	16.4
Na	46	36
Mn	8.0	0.0
K	1.7	1.5

Fluoridated water also is made by the company, by adding sodium fluoride tablets to processed water in such amounts as to yield about 0.8 ppm fluoride.

The Mountain Spring Water Company sells distilled water in five,- one-, and half-gallon bottles. Bottled drinking water is sold in five-gallon bottles and in smaller-sized crocks and ollas. The marketing area includes Shasta and parts of Trinity and Tehama Counties.

OLIVINE

Relatively pure, undeveloped deposits of olivine, of undetermined extent, are known at two locales near Castle Crags in Shasta County. This mineral, a silicate of magnesium and iron, is a major constituent of ultramafic rocks unless they have been altered to serpentine. The major belts of ultramafic rock in western Shasta County consist largely of serpentine, but apparently local areas within these belts have escaped serpentinization.

Olivine is used as a refractory material, in blasting sand, and as a component of high-magnesium, phosphate fertilizers. Refractory materials utilizing olivine include refractory brick, high-temperature mortar, and foundry sand. Foundry sand made of olivine has several advantages over sand composed of refractory-grade silica: 1) olivine withstands thermal shock without cracking or shattering, so that olivine sand lasts longer than silica sand; 2) olivine does not adhere to steel castings as much as does silica, thereby reducing cleaning costs; 3) olivine has very high softening and melting temperatures; and 4) foundry workers do not contract silicosis from olivine sand.

Starting in 1946, Permanente Metals Corporation in Santa Clara County, California, and Manganese Products, Incorporated, of Seattle, Washington, began producing fused magnesium-phosphate fertilizer. The Seattle firm obtained olivine from Cypress Island, Washington, and phosphate rock from Montana. The olivine contained 8 percent total iron as Fe_2O_3 (Waggaman, 1952, p. 387–390). These materials were shipped crushed to minus–1.5 inches and with a moisture content of less than 1 percent. Two parts phosphate rock and one part olivine were fed to an electric-arc furnace. Molten slag was tapped and quenched, and the resulting product was crushed and ground to minus–150 mesh, and bagged.

Permanente Metals Corporation had a similar operation, using phosphate rock from Idaho and serpentine obtained locally. The magnesium fertilizer contained about 20 percent available P_2O_5 and about 14 percent MgO. The Seattle operation began in 1946 and ended a short while before 1960, whereas the California operation was active from 1946 to about 1950.

Current information on the marketing and production of olivine is difficult to obtain. The principal commercial sources in the United States are a few companies in North Carolina and Washington. In 1950, prices per short ton for olivine, f.o.b. Puget Sound and North Carolina, were as follows: crude, $6 to $8; 20 mesh to dust, $14; minus–200 mesh, $18.

In 1951, the last year for which production figures were published by the U. S. Bureau of Mines, olivine production in the United States amounted to 8,816 short tons. Figures for 1952 and 1953 were not re-

ported, but in succeeding years the change in production compared to the previous year was published annually in "Minerals Yearbook" by the U. S. Bureau of Mines, as either a precise percentage or approximate indication (e.g., "slight" increase). Thus, if one assumes that there was little change in the quantity of production between 1951 and 1953, these data suggest that olivine produced in 1960 probably amounted to 25,000 short tons.

Reserves of potentially-commercial olivine in Washington and North Carolina total many millions of tons, but in spite of this, a suitable deposit in Shasta County might be in a competitive position with respect to San Francisco Bay area markets, because of the freight advantage over material from currently-active sources.

Shasta County Deposits

H. E. Hawkes, Jr. (1946) has described olivine crystals from the Little Castle Creek chrome mine (further described in the section on chromite, which see). The country rock in the vicinity of the mine is dunite that generally has been altered to serpentine. Some of the dunite is quite fresh, however, and contains olivine crystals that exhibit perfect cleavage; because of the cleavage, this mineral closely resembles pyroxene, which has no economic value. Careful microscopic examination of many samples of fresh dunite failed to reveal any pyroxene, Hawkes reported, although some samples contained traces of serpentine, chlorite, magnetite, talc, or carbonate minerals. Chromite in grains up to 1 mm. in diameter rarely comprises more than 1 percent of the masses of crystalline olivine. A chemical analysis of a sample of dunite from which traces of impurities had been removed follows (Hawkes, 1946, p. 281):

SiO_2	40.84
MgO	50.27
FeO	8.18
NiO	0.19
MnO	0.17
Fe_2O_3	0.13
Al_2O_3	0.19
TiO_2	0.04
H_2O	0.37*
	100.38

(*contains a little methylene iodide)

The analysis shows that the olivine contains 91.3 mol. percent Mg_2SiO_4, and hence is forsterite (magnesian olivine).

Hawkes does not describe the extent of the fresh dunite, but mentions (p. 278) in passing that it also occurs at the Lucky Strike chrome mine (see chromite section of tabulated list). This mine is situated southwest of Castle Crags, a few miles west of U. S. Highway 99. Olivine is exposed near an open cut from which chromite was mined, and crops out extensively for 1,200 feet along a ridge crest east of and 100 feet above the cut. On the ridge, the coarse olivine crystals begin to diminish in size and abundance about 1,000 feet north of the cut, shearing and serpentinization of the rock becomes more pronounced, and plagioclase crystals appear and become progressively more prominent. These changes probably are effected by the granitic rock that comprises Castle Crags, which stand between the Lucky Strike and Little Castle Creek mine four miles distant.

PETROLEUM AND NATURAL GAS

As early as June 17, 1865, the Shasta Courier, published weekly in the town of Shasta, announced that petroleum had been "proved to exist in paying quantities" near Cottonwood. There is no record of drilling activities resulting from this knowledge. Shortly after the turn of the century, a short-lived petroleum excitement resulted in the drilling of a few wells near Buckeye. The number of wells drilled, rock types encountered, and the nature of gas or oil "shows", if any, are not known.

Since 1930, six wells have been drilled in Shasta County for natural gas. Two wells at Happy Valley northwest of Olinda were drilled in 1930 and 1936 to depths of 500 and 245 feet, respectively. In 1952, a 461-foot well was put down four miles north of Anderson. The following year, a well 3,152 feet deep was drilled just northwest of Millville, encountering Cretaceous rocks at a depth of 514 feet. In late 1959 and early 1960, a deep well was put down near the Parkville Cemetery, six miles east of Anderson. In July 1966, Barnwell Industries of Shreveport, Louisiana, began drilling a wildcat well, Crow #1, in SE¼ Sec. 32, T. 32 N., R. 2 W., about four miles northeast of Millville. This well was drilled to a depth of 1889 feet in 1966 and abandoned in "diorite wash". Information on conditions encountered in these wells is kept confidential by the companies involved, but no production has resulted from any of them.

PUMICE, PUMICITE, AND VOLCANIC CINDERS

At least thirteen volcanic cinder pits in eastern Shasta County have been intermittently active since World War II. Most of the material obtained from these pits, which are described in the tabulated list, has been used in various phases of road construction by private companies and County and State road departments. In addition, some has been used for landscaping, in leach lines, and as aggregate for lightweight concrete block.

Two companies use Shasta County cinders in the manufacture of lightweight concrete block. Perk-O-Lite Concrete has a plant half a mile southeast of Pittville, just across the County line in Lassen County; pumice is obtained from a nearby deposit in Lassen County, and cinders from a pit in Shasta County seven miles south of the plant. Lightweight block is marketed in northern Tehama, Lassen, northeastern Shasta, and southern Siskiyou Counties. Stewart Masonry Supply of Redding obtains cinders from the Hackler pit southwest of Shingletown. Pumice is obtained from near Manton in Tehama County, and other cinders from the Mt. Lassen Cinder Company pit near Poison Lake, Lassen County. Manufactured block is marketed throughout northern California.

Pumice has not been mined in Shasta County, but several square miles just north of Digger Creek be-

tween Manton and Forward Mill are underlain by a deposit of white, dacitic pumice tuff. Its thickness ranges up to 200 feet. Pumice blocks up to eight inches across but probably averaging one inch are present, contained in a tuff matrix consisting largely of volcanic glass fragments ranging from a millimeter to 5 mm. in size.

Some pumice blocks are quite porous and have a silky luster, whereas others are fairly dense and lack the silky luster. The tuff is compact enough to support steep road cuts, yet loose enough to be excavated by front-end loaders.

Test data obtained by the California Division of Highways (1954–1955) on material from a quarry east of Manton show the following size distributions (percent passing screen):

	Sample	Percent passing		
		1	2	3
Screen size	inches 1	100		
	¾	97		
	⅜	92	100	
	mesh 4	85	97	100
	8	78	94	98
	16	69	87	91
	30	55	71	71
	50	40	53	42
	100	30	39	24
	200	22	29	17

Densities of dry briquettes made from this tuff range from 82 to 97 pounds per cubic foot, whereas specific gravities of minus-4-mesh material range from 2.2 to 2.6. Chemical analyses of the tuff (Wilson, 1961) show that it contains 69.44–67.99 percent SiO_2.

Lightweight concrete utilizing volcanic cinders has several advantages over concrete made with ordinary aggregate. Among these are decreased foundation sizes and savings in structural steel supports because of decreased loads, better heat and acoustical insulation, and better fire resistance. Relative disadvantages include greater cost, higher drying shrinkage, and need for greater care in placing the material during construction.

Specifications for raw material (pumice, cinders, and scoria) used in lightweight block or road construction are determined by the buyer. Public agencies purchasing these raw materials for road construction usually have standard specifications for the various uses (untreated base, cement-treated base, road-mixed surfacing, etc.) to which they might be put. In general, cinders should contain a certain amount of material in the fine-size range, which acts as a binder and aids in stabilizing the road base or surface. Sometimes a small proportion of cement or asphalt is added to achieve this result. On the other hand, the presence of extremely fine sizes of clay is considered detrimental. Sieve analyses of pit-run and processed material determine the sizes of material present. A separate test determines the sand equivalent, a value that indicates the amount of detrimental fines or clay-like material present; this is reported on a scale of 0 to 100, in which 100 represents clay-free material. The Los Angeles Rattler test measures the resistance of the material to impact and abrasion. A sample graded to a certain size is weighed and placed in a device similar to a small ball mill for 100 and 500 revolutions; the resulting weight loss is reported as a percentage of the original weight. Other tests that might be used include determinations of specific gravity (or density) and moisture content.

Pumice or cinders used in lightweight concrete block should have an attractive color, be free of organic impurities, contain enough fines for good binding, and be resistant to weight loss or size reduction during screening. In addition, purchasers of cinders for this use generally require delivery in batches of nearly-uniform color.

Royalties paid for cinders by the State Division of Highways in Shasta County range from three to 7.5 cents per ton, and five to 10 cents per cubic yard. Prices of cinders used locally for landscaping are arranged individually with the purchasers (usually nurseries or landscaping contractors). If cinders or scoria are cleaned, screened, sacked, and sold in metropolitan areas removed some distance from areas where volcanic rocks are common, the price range changes radically. In the cities east of San Francisco Bay, for example, medium-sized scoria blocks were sold retail during 1962 for 2.5 to three cents per pound (red) and four to 4.5 cents per pound (black). Cinders were sold for $1.25 to $1.65 in sacks of about one cubic foot, or $18 to $27 per cubic yard, loose.

Stewart Masonry Supply. Location: Sec. 24, T. 31 N., R. 5 W. (proj.) (plant), and Sec. 8, T. 30 N., R. 1 W. (pit), M.D.; plant situated south of Redding, pit about six miles southwest of Shingleton. Ownership: Burt Stewart, 6401 Eastside Road, Redding, California.

Stewart Masonry Supply has been situated in the Redding area since the fall of 1953. Raw material obtained from a variety of sources in northern California is processed into numerous shapes, colors, and types of lightweight concrete block, which are then marketed throughout northern California.

Four principal sources of supply are used by the company for raw material. One of the Hackler pits near Black Butte (Shasta County) yields black cinders; it is described in the tabulated list. White pumice obtained from a pit near Manton, Tehama County, is described in this text in the introduction to the section on pumice, pumicite, and volcanic cinders. Pumice also is obtained from Paint Pot Crater and Pumice Stone Mountain in Siskiyou County, just west of Little Glass Mountain; these deposits, acquired in 1962, replaced a source of supply formerly situated near Bend, Oregon. Red cinders are obtained from the Poison Lake pits of the Mt. Lassen Cinder Company, Lassen County. In this operation, the Mt. Lassen Cinder Company mines the cinders and screens them to two sizes (⅜-inch and minus–20 mesh) at a loading area; Stewart Masonry trucks that bring concrete blocks to Susanville pick up the cinders on their return trips.

The concrete block plant consists of a roll crusher and small, permanent screening unit that reduce raw material to the desired size range, when necessary. Aggregate, pumice, cement binder, and coloring powder (if the blocks are to be colored) are combined in a mixing unit, then transferred to a holding hopper. Pumice not only yields coarse clasts that function as part of the aggregate, but also a dust-like fraction that lightens the weight of the block and has a pozzolanic effect. Mixed material from the hopper is released to molds; water is added, and the material is automatically vibrated and compacted. Moist blocks are removed, placed on racks, and fired in a kiln for about four hours. Colored blocks are stored on racks for one to five days prior to firing, to permit the color to set. After firing, the blocks are steam-cured for eight to nine hours. The actual length of color setting, firing, and curing varies somewhat, depending on the size of the blocks, their exposed surface, and the weather. Final curing of the blocks is completed in the storage yard, and requires 28 days more or less, depending on temperature and humidity.

Manufactured products consist principally of hollow and solid concrete block (including split-face block), and roofing tile. A wide variety of "individualized" products can be made by using several different combinations of shape, size, and color. For example, late in 1962 the company offered 350 different combinations of hollow and solid block, utilizing nine colors and many shapes and sizes.

Blocks and tile are sold principally to dealers and contractors. The marketing area includes southern Oregon and points in northern California as widely separated as Susanville, Eureka, and Sacramento.

SAND AND GRAVEL

The principal sand and gravel deposits of Shasta County consist of streambed, floodplain, and terrace gravel accumulations along the Sacramento River and its larger tributaries. These deposits consist generally of well-rounded material composed of various metamorphic rock types, quartz, granitic rock, and—east of the Sacramento River—andesite and basalt. Minor deleterious rock types include sandstone, shale, conglomerate, tuff breccia and dacite. Sizes range from clay to large, unusable boulders. Other sources of sand and gravel include: dredge tailings, utilized at French Gulch and Reddings Bar on Clear Creek; continental volcanic gravel east of Millville; sand from the Montgomery Creek Formation near the settlement of that name; volcanic sand and gravel near Old Station; volcanic sand from Pliocene continental deposits near the junction of Hat Creek and the Pit River; and sand and gravel from Kosh Creek near Big Bend.

Seventeen deposits, including one commercial concrete-aggregate operation, are described in the tabulated list under sand and gravel, and four commercial, concrete-aggregate operations are described in the text of this report. In addition, four other areas in the County—largely undeveloped—have been investigated by the U. S. Bureau of Reclamation and State Division of Highways. These are the Churn Creek-Boulder Creek, Hat Creek-Pit River, Lamoine-Pollard Flat, and Millville-Palo Cedro areas. Typical test results on material from these areas, together with notes on the geology, are tabulated below (Table 3).

A brief explanation of the values reported as test data appears as a footnote to the table. An ideal aggregate has a high specific gravity and is free of clay and rotten particles that would disintegrate under normal usage or conditions of weathering. In the reported test results, the higher the values are for sand equivalent and R value, and the lower they are for absorption, the better is the quality of the aggregate, because such results indicate low proportions of clay. Likewise, the lower the values are for loss in the abrasion (L.A. Rattler) and soundness tests, the lower are the indicated proportions of rotten or unsound particles in the aggregate.

Sand and gravel is used principally in concrete aggregate and road or highway construction. This type of use is greatly affected by the number and size of public work projects active at any one time in the County or nearby. Production in 1961, valued at more than 2.7 million dollars, accounted for three-quarters of the County's total mineral production. In 1962, the value of sand and gravel production was less than half that of the year preceding, and, because of accelerated production of limestone and cement, amounted to less than 22 percent of the total mineral production from Shasta County. Approximately this ratio was maintained in 1965.

Prices paid for sand and gravel are variable, depending on the quality of the material, amount needed, accessibility of the area, and other factors. Private firms obtain material from their own property or else keep their leasing arrangements confidential, but records of the State Division of Highways show that royalties paid by the State or its contractors during recent years have ranged from three to eight cents per ton and seven to 11 cents per cubic yard. The Shasta County Department of Public Works estimates their range of average royalties paid has been 7½ to 10 cents per yard during recent years.

J. H. Hein Company. Location: Sec. 6, T. 31 N., R. 4 W., M.D., on the east bank of the Sacramento River just south of Highway 44, in Redding. Ownership: Estelle P. Hein, 1930 Court Street, Redding, California.

This company has been situated at its present location since 1941. Gravel originally was obtained from a series of pits a few hundred yards southwest of the plant site, in Section 1, T. 31 N., R. 5 W. It was excavated by a ½-yard dragline and trucked to the plant, where it was crushed by jaws and discs, and sized by vibrating screens. Prior to World War II, a brief attempt was made to recover gold as a byproduct, but was unsuccessful because of the extremely fine size of the gold.

After construction of Shasta Dam was completed in the middle 1940's, the company abandoned its gravel pits and began using an area about a mile south of the plant. By 1948, a Butler concrete-batching plant, under lease to J. R. Kettlewell (see tabulated list), and a hot-mix plant had been acquired. The concrete-batching plant was sold to Redding Transit Mix in 1960.

Photo 39. Loading gravel at the Rather-lease pit for J. H. Hein Company, Redding.

The Hein crushing and screening plant in 1963 consisted of primary jaw and secondary cone crushers, a roll crusher for fine sizes, multiple-deck vibrating screens, and a Wemco triple-screw classifier for washing sand. Additional washing of all sizes is accomplished by water sprays mounted above the screens. Several sizes of sand and gravel are produced by the plant, the capacity of which is between 50 and 75 tons per hour. About 45 percent of the products of this plant are used in concrete aggregate, 30 percent for bituminous aggregate, and 25 percent for road base.

The hot-mix plant uses ¾- to 3/16-inch gravel as feed, which is heated to 300–500°F. in an oil-fired rotary dryer, screened, and weighed into a batch hopper in specified amounts of each size. Gravel and oil then are mixed in a pug mill, and the hot mixture is loaded into trucks for delivery.

Phata 40. Ready-mix plant af J. R. Kettlewell in Redding, 1955. This equipment subsequently was acquired by Redding Transit Mix, Inc. Screening plant af J. H. Hein Campany in backgraund.

Gravel is obtained under lease from a pit 1.2 miles south of the plant. It is excavated by a ¾-cubic-yard Northwestern dragline and moved to the plant by truck. The pit is in a flood plain deposit, covers an area about 1,300 by 1,800 feet, and has a pond which is maintained by diversion of water from the nearby Sacramento River. There is little or no overburden or vegetation. The sand and gravel are poorly sorted, but some stratification is apparent. A long, 15-foot-high face south of the pond exposes a few thin layers of clayey sand, but in general, clay is not an important constituent.

About 60 percent of the deposit consists of flattish, gravel-sized particles, less than a percent of which appear to consist of rotten material. Most of the gravel consists of fine-grained metamorphic rock types (greenstone, quartzite, slate); there are some volcanic and coarse-grained metamorphic rocks present, and very little quartz. Sandstone particles present contain some organic impurities. The deposit is deficient in sand. At a depth of six feet below water level, it rests on a layer of boulders up to three feet in diameter that marks the lower limit of excavation. Because of the flood-control effect of Shasta Dam, there is little or no replenishment of the deposit during the winter.

The following test data on prepared sand and gravel are typical of results obtained by the State Division of Highways (a brief explanation of the tests appears as a footnote to Table 3, Miscellaneous sand and gravel deposits, Shasta County).

Oaks Sand and Gravel Company. Location: Sec. 30, T. 31 N., R. 4 W., M.D. (proj.), on the Sacramento River north of the mouth of Clear Creek, about five

Table 3. Miscellaneous sand and gravel deposits, Shasta County.

AREA	PROPERTY	LOCATION	SAMPLE SOURCE	SIEVE ANALYSIS (% PASSING SCREEN)								
				INCH								
				3	2½	2	1½	1	¾	⅜	4	8
Churn Creek-Boulder Creek	Churn Creek	About 3 mi. NE of Redding. E of bottom of Churn Cr., probably in NE¼ Sec. 18, T 32 N, R 4 W, M.D.	Drill bole 5.3 ft. deep.	96	96	95	88	77	71	54	39	29
	Cburn Creek	About 3 mi. NE of Redding. W of bottom of Churn Cr., probably near center of N½ N½ Sec. 18, T 32 N, R 4 W, M.D.	Drill hole 10.6 ft. deep.	98	96	91	86	74	68	51	39	30
	Boulder Creek	About 2 mi. NE of Redding. S of Hwy. 299. SE¼ Sec. 19, T 32 N, R 4 W, M.D.	Two drill holes 638 ft. and 1,071 ft. S of Hwy. 299.	77–91	73–88	69–78	61–70	51–64	47–58	39–44	31–32	25
Hat Creek-Pit River	Kettlewell and Hertel Pit	11 mi. NE of Burney, N of Hwy. 299. W½ SW¼ NW¼ Sec. 18, T 36 N, R 4 E, M.D.	Test bole.	76	74	72	64	55	49	38	30	24
	Hat Creek Pit	11 mi. NE of Burney, N of Hwy. 299. NE¼ SE¼ Sec. 18, T 36 N, R 4 E, M.D.	Pit face.							100	97	88
	P.G.&E. Pits	11 mi. NE of Burney, N of Hwy. 299. S½ SE¼ Sec. 12, T 36 N, R 3 E, M.D.	Windrow in pit.	94	88	83	76	66	60	47	39	34
Lamoine-Pollard Flat	Buese	On E side Sacramento R., opposite Lamoine. W½ SW¼ Sec. 15, T 36 N, R 5 W, M.D.	Test holes.	74	66	47–62	41–58	35–55	32–52	27–45	22–36	18–28
	Pollard Gulch	On W side of concave-west bend in Sacramento R., 1½ mi. NE of Lamoine. SW¼ NE¼ Sec. 11, T 36 N, R 5 W, M.D.	Test holes.			37–47	33–41	28–33	25–30	19–21	14–15	12
	North Salt Creek	On W side of concave-west bend in Sacramento R., 2 mi. NE of Lamoine. N½ NE¼ Sec. 11, T 36 N, R 5 W, M.D.	Cut face.			56–61	49–52	43–44	38–39	29–31	21–25	17–22
Millville-Palo Cedro	Haley	E side of Cow Cr., 2¼ mi. S of Palo Cedro. Center W½ W½ NW¼ Sec. 20, T 31 N, R 3 W, M.D.	Creek run.	92	80	69	59	47	40	28	20	14
	Logan	Little Cow Cr. streambed, 300–2,000 ft. N of Hwy. 44. W½ SE¼ Sec. 5, T 31 N, R 3 W, M.D.	Test holes about 5 ft. deep.				75–80	66–68	59	40–43	28–31	23–25
	Oak Run Creek	Oak Run Cr. streambed, 1½ mi. NW of Millville, 150 ft. E to 600 ft. W of Hwy. 44. Near center S½ Sec. 3, T 31 N, R 3 W, M.D.	Creek run.	82–90	77–83	70–77	61–65	55	37–46	26–31	26–31	19–23
	Clover Creek	Clover Cr. streambed, ½ mi. NW of Millville, between Hwy. 44 and Cow Cr. N½ SE¼ Sec. 10, T 31 N, R 3 W, M.D.	Creek run, 350 ft. downstream from Hwy. 44.	79		70	55	45	40	30	24	21
	Millville Plains	"On Highway No. 44, three miles south of Millville" (U.S. Bur. Reclamation, 1938).	Unknown.									
	Palo Cedro	2 mi. N of Palo Cedro, in or near Little Cow Cr.	Unknown.									

Explanation of test data.

LA Rattler: measures resistance of material to impact and abrasion, expressed by percent weight lost after 100 and 500 revolutions of rotating cylinder.
Sand equivalent: indicates proportion of detrimental fines present, expressed as a value on a scale of 0 to 100 in which 100 is clay-free material.
Moisture: loss in weight determined by weighing sample before and after oven drying; expressed as percent of original weight.
Absorption: amount of moisture a sample is capable of absorbing, expressed as percent of original weight.
Soundness: measures resistance of material to disintegration by sodium- or magnesium-sulfate solution. Each size fraction is tested, and average weight loss for entire sample is reported as percentage of original weight.
R value: resistance, mostly frictional, that fine material to be used as sub-grade or base offers to plastic displacement reported on arbitrary scale in wbich 0 is a liquid and 100 a solid.

SIEVE ANALYSIS (% PASSING SCREEN)								SAND EQUIVALENT	SPECIFIC GRAVITY		% MOISTURE	REMARKS
MESH						LA RATTLER						
16	30	50	100	200	270	100r	500r		+4 mesh	−4 mesh		
19	11	5	2	2	2			54			5.4–8.5	Gravel well rounded, somewhat flattish in shape. Metavolcanic rock dominant, with much black quartzite and banded slate. Some quartz and granitic rock. Maximum cobble size is 12 in.; locally up to 5% of gravel is +6 in. Gravel is in deposit 5 to 10 ft. thick above resistant sandstone; W of creek is capped by thin mantle of red soil. LA Rattler and specific gravity values are for material from the 10.6-ft. hole, crushed to minus ¾ in.; absorption value of 0.9 also obtained on this material. U.S. Bur. Reclamation (1938) reports "high percentage of deleterious sandstones, shales, and conglomerate, as well as small amounts of dacite tuffs and lavas".
22	13	6	3	2	2	4.4	19.4	73	2.71	2.75	5.2–8.6	
17–18	12–14	9–10	7–8	6–7	5–6			24–25			7.3–9.5	Moderately- to lightly-cemented cobbly sandstone about 5 ft. thick over clay, in floodplain deposit. Gravel well-rounded, moderate proportion of flattish pieces. Greenstone, metarhyolite, and metaconglomerate common. Some fine grained andesite and metasedimentary rocks. Rotten particles, chiefly granitic rock and coarse grained metavolcanic rocks, comprise about 5% of +2 in. material.
18	10	5	2	1				80	2.53	2.70	0.7	Cross-bedded, gray volcanic sand, with layer of diatomite(?) 10 ft. thick interbedded in upper part of pit face, on E side. Overburden 4 ft. thick. Material drains freely. Pit face 80 ft. high, 125 ft. across. U.S. Bur. Reclamation (1938) reports "unlimited quantity of graded sand which apparently contains pozzolanic material", present in "Sand Pit" area in this vicinity.
68	41	18	5	2				88		2.67		Gray, cross-bedded, coarse volcanic sand with thin layers of clay a few inches thick. Minor, gentle anticline plunges 10° southward. Some compaction faulting. Thin overburden. Fragments of volcanic rock, and crystals of hornblende and plagioclase, common. Semicircular pit face 70 ft. high, 150–200 ft. long.
24	15	7	4	3	2	4.4	22.2		2.58	2.71		Poorly sorted gravel in series of broad, shallow pits in terrace or flood plain of Hat Creek. Rock types present include andesite, basalt, dacite, and scoria and vesicular flow rocks. Sand contains quartz, feldspar, olivine, hornblende, epidote, and magnetite. Some organic impurities. Loss during soundness test = 0.8%. Absorption = 1.8%.
14–18	8–9	3–6	2–4	1–3	1–2			67–79	2.55–2.63	2.54–2.75	0.9	Gravel terrace containing estimated 30,000 yds. About ⅓ mined by placer methods, leaving large cobbles and boulders. Organic impurities present. Loss during soundness test = 2.7%. Absorption = 3.0–5.2. R value = 77–82.
10	7	4–5	2–3	1–2	1–2			65–79	2.67	2.80–2.84	0.8–0.9	Gravel bar containing many boulders 2½–3 ft. across. Rock types include granitic rock, gabbro, serpentine, indeterminate ultramafic rocks, andesite, basalt, and dacite. Sand contains feldspar, quartz, magnetite, hornblende, olivine, biotite, and muscovite. Loss during soundness test = 1.6%. R value = 79–85.
12–16	7–8	4	2	2	1–2	5.4	25.0	69–80	2.67	2.80	0.9–1.2	Gravel terrace 25–30 ft. deep contains boulders up to 4 ft. across, has some shingling, no sorting. Rock types include granitic rock, gabbro, diorite, amphibolite, meta-sandstone, serpentine, and andesite. Sand contains same minerals as Pollard Gl. deposit, and chlorite in addition.
9	6	4	2	2		4.2	21.4	72	2.58–2.66	2.67–2.74	0.6	Gravel terrace with abundant cobbles, as much as 10 ft. deep. Rests on massive tuffaceous sandstone. Drains freely. R value = 80–83. All tests except sieve analysis and % moisture are on −1½ in. material.
18	11–14	4–5	1	1	1	4.0–4.4	17.8–18.6	75–76	2.58	2.61–2.69		Gravel well rounded, commonly flattish in shape. Main rock types are volcanic (with andesite dominant), quartzite, metavolcanic rock. Worked by bulldozer and front-end loader in December 1962.
14–16	9	4–6	2	1–2	1			61–62			1.0–1.3	Narrow gravel bar about 4 ft. thick, on massive tuffaceous sandstone. Volcanic rock types dominant. R value = 79–82.
18	12	7	5	4	3			36			3.4	Cobbles and large sizes gravel common. Volcanic rock types dominant. R value = 78.
									2.54	2.28		Sand has high clay content; silt content = 36.3%. Material is cemented. Absorption = 2.9. Data from U.S. Bur. Reclamation (1938).
									2.57	2.60		Gravel is "dirty". Losses during soundness test = 14.3% and 17.2% for sand fraction and gravel fraction, respectively. Data from U.S. Bur. Reclamation (1938).

1½-in. PCC gravel		PCC sand	
Screen size	Percent passing	Screen size	Percent passing
2 in.	100	⅜ in.	100
1½	93	4 mesh	99
1	29	8	83
¾	3	16	61
½	0	30	38
		50	15
		100	4
		200	2
		270	2

	Sand equivalent	Specific gravity +4 mesh	Specific gravity −4 mesh	LA Rattler 100r	LA Rattler 500r	Absorption	Soundness
Gravel		2.70–2.72				0.8–0.9	1.3–1.5
Sand	71		2.59–2.74	3.2	16.0	3.0	3.1–4.4

miles south of Redding. Ownership: G. E. Oaks, Jr., 7140 Pit Road, Redding, California.

The first published mention of this property is by Logan (1926, p. 201), who noted that a seasonally-operated crushing and screening plant powered by two tractors, and with a capacity of 150 to 200 cubic yards, was being leased by the Savage Brothers from its owner, G. E. Oaks. By 1938, the plant had been removed. Processing and production of concrete aggregate began in 1941.

In 1948, sand and gravel was being excavated by a tractor-carryall combination from a pit 400 feet from the plant, which consisted of vibrating screens, storage bins, and a concrete batching plant with a capacity of 185 cubic yards in eight hours. A concrete block plant on the property was capable of producing 2000 cement or pumice blocks in eight hours. The capacity of the aggregate plant was increased to 300 yards by 1951, fine gold was recovered on burlap as a byproduct, and the carryall was replaced by a ¾-yard dragline. Around 1959, the plant capacity was 100 cubic yards per hour. It consisted of a primary gyratory crusher, secondary jaw and cone crushers, vibrating screens, sand classifiers, and a ball mill that produced sand when the aggregate otherwise would have been sand-deficient. Sand and gravel was obtained from Clear Creek and hauled 1,000 feet to the plant. Minus-¼-inch material was passed over a jig that recovered byproduct gold.

In 1960, gravel was obtained from a pit on Clear Creek 3 miles upstream from the plant, but in 1962–1963, a pit 0.6 mile distant was used. The plant consists of two multiple-deck screening units similar to that operated in 1959, except that use of the ball mill and gold-recovery unit was discontinued and a log washer and trommel are used to remove soft particles. Water for washing is obtained from the Sacramento River and from a well on the property. The concrete batching plant has a capacity of 250 cubic yards in 8 hours. The company estimates that, over a long period of time, three-quarters of its sales have been in the Redding area, mostly delivered to the job. Delivery is made by transit-mix trucks of three- to 1½-yard capacity. A formerly-operated Madsen road-mix plant of 3,000 pounds capacity, together with the crushing equipment, was leased to Morgan Construction Company.

Photo 41. Primary crusher and screening plant of Oaks Sand and Gravel Company in 1955.

Coarse gravel consists dominantly of fine grained metamorphic rocks (mostly metasediments), many of which are prominently veined with quartz. Acidic and basic metavolcanic rocks comprise about 15 percent of the gravel, metaconglomerate of the Bragdon Formation about 15 percent, and trondhjemite and quartz diorite about 5 percent each. [Goldman (1961, p. 19) reports the following proportions of rock types: granitic 24%, sandstone 24%, quartzite 14%, conglomerate 8%, metavolcanic 7%, schist and gneiss 7%, gabroic 4%, acid volcanic 4%, vein quartz 3%, slate 3%, chert 2%.]

Sand and gravel was obtained during 1962–1963 from bars and shallow banks of Clear Creek, where only occasional stripping was needed. The dominant sizes appear to be in the one- to three-inch range, but material from sand to eight inches across is present. Gravel was excavated to about four feet below water level during the summer and fall, below which a thick layer of blue clay is present. There is some stratification and no cementation. A fines pit about 0.3 mile northwest of the plant was used formerly, when additional material in the fine-sizes range was needed. Stratified, clean, friable sand in this pit is exposed beneath about four feet of loam overburden. Thin layers of interbedded gravel and cobbles are present, together with a few layers of clayey sand.

The following test data on prepared sand and gravel are typical of results obtained by the State Division of Highways (a brief explanation of the tests appears as a footnote to Table 3, Miscellaneous sand and gravel deposits, Shasta County).

1½-in. PCC gravel		PCC sand	
Screen size	Percent passing	Screen size	Percent passing
2 in.	100	⅜ in.	100
1½	95	4 mesh	98
1	39	8	83
¾	5	16	53
⅜	1	30	26
4 mesh	1	50	12
		100	5
		200	3

	Sand equivalent	Specific gravity		LA Rattler		Absorption	Soundness*
		+4 mesh	−4 mesh	100r	500r		
Gravel		2.63–2.69		4.8–6.2	22.6–27.6	1.5–1.7	2.1–7.5
Sand	80–90		2.56–2.64			2.0–2.5	3.5–4.7

(* Soundness loss is for different series of tests reported by Goldman, 1961, p. 17.)

Redding Sand and Gravel, Inc. Location: Sec. 31, T. 32 N., R. 4 W., M.D., and Sec. 36, T. 32 N., R. 5 W., M.D. (proj.), adjacent to the Sacramento River at the east end of Butte Street in Redding. Ownership: Frances Kutras, Redding, California. Leased to Redding Sand and Gravel Company, J. H. Trisdale, President, East Butte Street, Redding, California.

This property, formerly known as the Kutras deposit, was tested and studied in detail by the U. S. Bureau of Reclamation as a possible source of concrete aggregate for use in the construction of Shasta Dam. Eighty-six test pits were dug to the water table and 19 drill holes were put down to greater depth. The Bureau's report (1938) contains a detailed discussion of the character of a composite sample obtained "from Pit I-11 and vicinity of the Kutras tract". Because of its thoroughness and application to other deposits situated on the Sacramento River, this discussion is summarized below.

Metamorphic rock types are dominant in both the sand and gravel fractions of the deposit. Other rock types present include basalt, andesite, granitic rock, diorite, volcanic tuff, chert, shale, rhyolite, sandstone, limestone, and conglomerate. The most important metamorphic rock types are slate and greenschist. Under "slate" are included hornfels, argillite, and well indurated shale, as well as true slate.

The true slate consists of hard, dense, black, flattish, well rounded, elongate pebbles. Petrographic examination revealed that the material is mostly clay slate rather than the generally harder, less absorptive, and more desirable mica slate. Undesirable features of clay slates include the following: 1) presence of clay minerals that cause swelling by absorption of water; 2) presence of bedding planes that promote decomposition and disintegration; 3) presence of sulfides that, by oxidation, produce sulfuric acid, which is harmful to concrete; 4) low tensile and comprehensive strengths; and 5) smooth surfaces that form poor bonds in concrete. The report concluded that "the different slates examined in the Kutras aggregate show any or all of these deleterions factors", as does also the greenschist when a slate-like structure is developed.

The general form of the gravel is rounded, but flat shapes begin to appear in the 4-mesh size. In the sand fraction, the predominant shape is "flat-rounded" except in the finest sizes, where angular particles are present.

A wide variation in the silt content of the sand fractions from various test holes was noted by the Bureau; the range of variation was as much as 12 percent, and the average silt content was 4.9 percent. A slight, siliceous, clay-like coating on the gravel was noted, but did not occur in deleterious amount. Specific gravity and absorption also vary considerably. Loss during the Los Angeles Rattler test (500 revolutions) amounted to 16.8 percent. Sodium-sulfate soundness tests yielded losses of 9.5 percent for sand and 10.4 percent for gravel.

In spite of the difficulties in utilizing the deposit made apparent by the Bureau's report, it was selected as the source for concrete aggregate for Shasta Dam, and almost 12 million tons of sand and gravel were excavated from the property for that purpose by the Columbia Construction Company (see tabulated list). A complicated flow sheet was used to eliminate unsuitable material from the aggregate and to supply specified proportions of fines, in which the deposit was deficient (Tyler, 1945, p. 100). The company ceased producing in 1944. Redding Sand and Gravel Company acquired the property around 1945, when new equipment was installed and stockpiles of sized aggregate left by Columbia were re-processed.

The deposit is dug above water line in two benches 8 feet high by a power shovel fitted with a 1½-cubic-yard bucket. A third bench dug by a dragline includes material two feet above and eight to 15 feet below water; digging is stopped at a layer of large boulders. These deposits are not replenished by seasonal floods because of the presence of Shasta Dam farther upstream.

Sand and gravel from the pits is loaded into dump trucks and hauled to the crushing and screening plant. The crushing and screening plant is equipped with a primary jaw, secondary cone, and tertiary roll crushers, screens, and a sand screw. The multiple-deck vibrating screens are fed by belt conveyors, and all material on the screens is washed with a water spray. Any desired size of material can be obtained by installing the proper sizes of screens, but the material as dug from the pit is deficient in sand. A roll crusher is used to manufacture fines for the asphalt plant mix. The crushing and screening plant has a capacity of about 125 tons per hour.

The Redding Sand and Gravel Company also operates a Madsen hot road-mix plant in which crushed material passing through a ¾-inch screen is dried and

Photo 42. Redding Sand and Gravel Company in Redding, April 1955. View east is of crushing and screening plant. Conveyor on left went to the plant formerly operated by the Stuts Crete Corporotion.

mixed with hot oil. The product from this plant is sold to contractors for building and repairing roads.

A Noble batching plant was formerly operated at this site by the Stuts-Crete Corporation and, later, by J. R. Kettlewell (see tabulated list).

The deposit consists of gravel bars and flood-plain alluvium covering an area roughly 1,600 feet square. There is practically no overburden, and the deposit is bare except for small patches of vegetation. The sand and gravel is poorly sorted and unstratified, and there are many cobbles 8 to 10 inches and some up to 16 inches in size. The following proportions of rock types are reported by Goldman (1961, p. 26): metavolcanic 35%, diorite-gabbro 26%, silicified sandstone 14%, hornfels 12%, andesite 7%, basalt 2%, chert 2%, shale 2%.

The following test data on prepared sand and gravel are typical of results obtained by the State Division of Highways (a brief explanation of the tests appears as a footnote to Table 3, Miscellaneous sand and gravel deposits, Shasta County).

1½-in. PCC gravel		PCC sand	
Screen size	Percent passing	Screen size	Percent passing
2 in.	100	⅜ in.	100
1½	98	4 mesh	94
1	39	8	78
¾	10	16	58
½	1	30	39
⅜	0	50	19
		100	7
		200	3

	Sand equivalent	Specific gravity		LA Rattler		Absorption	Soundness
		+4 mesh	−4 mesh	100r	500r		
Gravel		2.72–2.73		3.2–3.4	16.2–17.2	0.9–1.0	2.3–4.7
Sand	80–92		2.60–2.65			2.4–2.9	3.8–5.6

Shea Sand and Gravel. Location: Sec. 30, T. 31 N., R. 4 W., M.D. (proj.), immediately east of the Sacramento River opposite Clear Creek, about 3½ miles south of Enterprise. Ownership: J. F. Shea Company, Inc., 1290 Smith Road, Redding, California.

The sand and gravel plant of this company began operating late in 1958, when the Shea-Kaiser-Morrison/Knudsen-Macco-Raymond combine had the job of providing a two-foot concrete lining for almost 11 miles of tunnel 17.5 feet in diameter, between Lewiston and Whiskeytown Reservoirs. During this time, the entire output of the plant was used by the job contractors. Following completion of this phase of the Trinity River Project, the gravel plant, operating as Shea Sand and Gravel, began producing commercial aggregate. Redding Transit Mix, Inc. (see tabulated list), was formed in 1960 with Edmund H. Shea and others as directors; this company receives all of its aggregate from the Shea plant. Shea Sand and Gravel in addition provides material to customers as widely situated as Modoc, Siskiyou, Trinity, and Butte Counties.

Sand and gravel is excavated from a pit on the east bank of the Sacramento River by a dragline with a three-cubic-yard bucket. Euclid dump trucks carry the material half a mile to the plant. A grizzly scalps plus-4-inch material, which is sent to an "oversize" storage pile.

Sand and gravel passing through the grizzly goes to a 4-mesh wet screen. Undersize is sent through sluice boxes lined with screens and burlap that recover small amounts of gold as a byproduct. The undersize then goes to a two-deck vibrating screen; middle and coarse sizes from this screen are sent directly to stockpiles, whereas the fines are cleaned in hydraulic-classifier tanks and dewatered in a double sand screw before being stockpiled. Oversize from the 4-mesh screen is scrubbed in a rail-lined trommel and sent to a three-deck vibrating screen. Gravel larger than 2½ inches is rejected and sent to an "oversize" storage pile; the remaining gravel is stockpiled in three sizes (plus–¼, plus–¾, and plus–1½ inches).

Oversize from the vibrating screen (plus–2½ inches) and the grizzly (plus–4 inches) are processed by a jaw crusher and screens, with a cone crusher in closed circuit.

The several sizes of sand, gravel, and crushed rock thus produced can be blended in various proportions to meet the specifications of any job. The screening plant has a capacity of 400 tons per hour, whereas the crushing unit processes 200 tons per hour. Water for the screens is obtained from wells on the property to meet the plant requirements.

The gravel pit on the east bank of the Sacramento River has about two feet of overburden exposed in the face, which extends about 10 feet above water level. There are no cemented layers present, only a few clay lenses, and stratification is pronounced only locally.

Rock types are dominantly metasedimentary rocks and greenstone, with granitic and volcanic rocks comprising about a quarter of the plus-2-inch gravel. Small proportions of ultramafic rocks, hornfels, schist, sandstone, shale, quartz, and chert are also present. The sand fraction contains fragments of various rock types, quartz, feldspar, pyroxene, magnetite, and (in one sample) volcanic glass shards.

The following test data on prepared sand and gravel are typical of results obtained by the State Division of Highways (a brief explanation of the tests appears as a footnote to Table 3, Miscellaneous sand and gravel deposits, Shasta County).

1½-in. PCC gravel		PCC sand	
Screen size	Percent passing	Screen size	Percent passing
2 in.	100	⅜ in.	100
1½	93	4 mesh	97
1	31	8	78
¾	3	16	61
½	1	30	40
⅜	0	50	20
		100	8
		200	3

	Sand equivalent	Specific gravity		LA Rattler		Absorption	Soundness
		+4 mesh	−4 mesh	100r	500r		
Gravel		2.69–2.71		3.0–3.6	15.0–19.0	0.5–1.1	2.3–2.8
Sand	83–87		2.61–2.63			2.4–2.9	3.8–4.1

STONE

Stone, Crushed

Numerous small pits throughout Shasta County have been excavated to provide small quantities of crushed rock for small jobs usually connected with maintenance or repair of public or private roads. Separate figures on the value or quantity of crushed stone produced in the County are not available. Eleven sources of crushed stone in Shasta County are described in the tabulated list, and test data are presented where available. Rock types involved are basalt, andesite, and various metamorphic rocks. In addition, dump material from a gold mine and the Spring Creek Tunnel, consisting of greenschist-quartz and granitic rock, respectively, has been used.

Desirable characteristics in a deposit to be worked for crushed stone include ease of access; closeness to the contemplated job; favorable position for excavation (on a gentle hillside or, if a pit must be dug below ground level in a flat area, enough room for maneuvering); and hard, sound rock that is already broken to sizes not larger than several inches across, or that can be broken to such sizes by ripping, light blasting, or normal excavating.

Soundness of crushed rock is indicated by the results of several tests. Sand equivalent and absorption are indications of the clay content of the rock, or of the proportions of very fine sizes produced by crushing; high sand-equivalent values (on a scale of 0 to 100) and low percentages of absorption indicate a low clay-fine content, and hence are favorable indications. A low specific gravity is an indication of weathered rock or else of rock that might not be strong enough to withstand hard usage. High R values (on a scale of 0 to 100) and low abrasion losses indicate rock that is tough and durable.

Stone, Dimension

Dimension stone is any natural rock that is cut or broken to a definite size and shape; the term includes cut, carved, roughhewn, and polished types of stone. Types of rock quarried in Shasta County for this purpose include shaly tuff, biotite quartz diorite, massive graywacke, and welded tuff. They were quarried principally around and before the turn of the century.

Marketable dimension stone must be durable, strong, readily workable in the quarry, relatively nonporous, hard (if it is to be subjected to wear; for example, curbing or floor tile), and attractive. All of these characteristics can be determined objectively—by laboratory tests or observation at the potential quarry site—except for attractiveness, which is entirely subjective. Beauty truly is in the eye of the beholder, and an aggressive advertising and marketing campaign can do

much to win public acceptance of and desire for a particular kind of rock. In addition, the deposit being quarried must be large enough to assure delivery of whatever tonnages the buyer wants.

Dimension stone usually is sold to nurseries, building contractors, and construction-material dealers. Prices and conditions of delivery are determined by mutual agreement of seller and buyer. Quotations of retail prices of stone vary widely. Black, vesicular basalt, usually with moss or lichens, was sold retail in

Photo 43. Elliott stone deposit. Variegated sholy tuff frogments ore trimmed, polished ond sold locally os knickknacks.

Sacramento for four cents per pound in 1963, whereas it could be obtained for 1½ to 2½ cents per pound in the cities east of San Francisco Bay. Sizes ranged from small (a "few" pounds) to large (1,500 pounds). One firm in Shasta County sold small lots of decorative stone of various types to contractors for about $18 per ton.

During 1963, two firms in Shasta County carried sizable stocks of dimension and decorative stone, and a third would supply such material on request. Sources of material included Arizona and Oregon, and Modoc, Siskiyou, Lassen, Tehama, and Butte Counties. Rock types included scoria, welded tuff, large pumice boulders, flat slabs of vesicular basalt, granodiorite, milky quartz, serpentine, massive greenstone, banded quartzite, slate, and other types of metavolcanic and metasedimentary rock.

Although many of these rock types could have been obtained from Shasta County with no loss in visual attractiveness, no local material was carried because it lacked status as something different or unusual. This appeal to the customers' desire for prestige or status is a strong factor in marketing stone, and accounts for the fact that most natural stone is transported surprising distances before being sold.

SULFUR

Sporadic production of sulfur, amounting to only a few tons, is reported from Supan's Sulphur Works south of Lassen Peak prior to 1900. Pyrite mined at Iron Mountain by the Mountain Copper Company, Ltd., between 1907 and 1963 was roasted for its sulfur content, used in the manufacture of sulfuric acid. This operation is described in the pyrite section of this text.

TALC

Small lots of steatite talc were shipped from the Ganim mine near Whiskeytown Reservoir during 1925–1927 and in 1940 and 1946. No other potentially commercial occurrences of talc are known in the County.

Ganim mine. Location: Secs. 5 and 8, T. 32 N., R. 6 W., M.D., about 11 miles northwest of Redding. Ownership: Ganim Gold Mining Company, William G. Thompson, secretary, Redding, California.

The Ganim mine was first worked for gold, and by 1921 had been developed by several crosscut adits 50 to 400 feet long, and by drifts and surface pits. Talc was found in the main, 900-foot adit prior to 1926, and several carloads were shipped each year from 1925 to 1927. During the early 1930's, prospecting and development again concentrated on gold.

In May 1941 the Pomona Tile Company leased the Ganim mine and mined a carload of talc from a stope about 600 feet from the portal of the main adit. In October 1941, Paul E. Littel of Redding mined a second carload of talc from the same stope. There was no further production from this deposit until March 1946 when Littel opened up a lens of talc on the surface, northwest of the underground stope. Talc was exposed for a width of 20 feet, and material selectively mined from the outcrop was valued at $12.00 per ton delivered to the railroad at Redding; only a small production was reported. During 1959, lessees cleaned out some of the caved workings.

The production of gold ore from this property is not known. Page and Wright (1943) reported that

Photo 44. Portal of the main adit of the Ganim talc mine. View N. 72°W.

production of talc of all grades amounted to about 2,400 tons, and that the property had been worked "primarily" for gold and silver.

Country rock at the Ganim mine consists entirely of moderately-altered Copley Greenstone. A north- to northwest-trending zone of intensely altered greenstone, the dip of which ranges from vertical to moderately northeast, consists mainly of chlorite and has a schistose appearance imparted by thorough shearing.

This zone is 10 to 100 feet wide at the surface and has been traced for more than 1,200 feet. Talc at the mine is confined to this zone; it consists of two main lenses of relatively-pure, high-grade talc and a broader mineralized zone composed of a mixture of talc and carbonate rock.

The northern of the two main talc bodies is the only one that has been worked; it dips 37° NE, has a strike length of 180 feet, and is estimated to contain 21,000 tons of talc ore. The southern body, exposed only on the surface, contains 2,000 tons. Together, both bodies might yield 8,000 tons of steatite-grade talc (Page and Wright, 1943). The small lens mined by Paul Littel in 1946 strikes N. 15° W. above a greenstone footwall that dips 60° E. This probably is the lens, 80 feet long and 10 feet wide, shown on the map by Page and Wright several hundred feet north of the main adit.

Logan (1926, p. 211) reports the following assays of talc.

SiO_2	60.75	61.90
Fe_2O_3	0.88	0.65
Al_2O_3	2.28	0.87
MgO	30.40	30.34
Ign loss	5.73	
moisture	----	0.26
combined water	----	4.90
Alkalies (by diff.)	----	0.90
Mn_3O_4	----	0.18

The relative positions of the talc and the veins of quartz and siliceous wall rock worked for gold are not apparent from the work of Page and Wright. Tucker (1922, p. 371) reports a quartz vein intersected by a crosscut adit at an elevation of 1,800 feet; it contained bornite, chalcopyrite, and $15 per ton in gold. Averill (1933, p. 26–27) reports that the lowest, main level intersected talc between two zones of siliceous, sulfide-bearing rock that contains pyrite with subordinate chalcopyrite, sphalerite, and galena; gold assays of $1.50 to $2.00, and occasionally as high as $50, per ton were noted. A quartz vein "higher on the hill" contained copper sulfides and carbonates and $8 to $10 per ton in gold.

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Tabulated List of Mines and Mineral Deposits of Shasta County

Mines and mineral deposits are alphabetically arranged in this list, first by commodity and then by name of property. The numbers in the first column identify the property on the map of Shasta County that accompanies this report. The names listed are those most commonly used. Many mines or claims may have lost their identity because their names have been changed or because they have been grouped with others under the name of the principal property of the group. Some properties have, no doubt, been abandoned. The names of the owners or operators were obtained when the property was visited or from Shasta County records; an owner listed is not necessarily the sole owner. Much of the ownership information was obtained during 1956 and 1957, but additional information was secured during 1962 where important changes in activity had occurred. The owners of many idle properties are listed as "Undetermined". When addresses are given for towns in California, the name of the State is omitted.

The references in the last column are to publications appearing in the bibliography. The author's name is followed by the abbreviated date of publication, and page numbers. References are separated from each other by semicolons.

CADMIUM

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Mammoth Copper group...	Sec. 32, T 34 N, R 5 W, MDB&M	U.S. Smelting, Refining and Mining Company, Salt Lake City, Utah	Cadmium occurs in greenockite associated with sphalerite in the ores from this mine.	Several thousand pounds were recovered at electrolytic zinc plant in 1917–18 at Kennett. See also description in copper section, herein. (Bradley 22:241; 23:114–115.)

CHROMITE

	Andrews prospect.....	T 36 N, R 5 W, MDB&M.	Undetermined.....	.....	Prospect NW of Lamoine. Developed in 1917. Idle. (Bradley 18:181, 222.)
	B. & S.....	T 36 N, R 5 W, MDB&M.	Undetermined.....	1,000 tons ore estimated remaining in 1918.	Near Lamoine. Shipped 2 tons prior to 1918. Idle. (Bradley 18:222.)
	Beegum Chrome.....	.....	.....	.....	See Round Bottom, herein.
	Black Bird.....	.....	.....	.....	See Forest Queen, herein.
	Brown.....	.....	.....	.....	See Little Castle Creek, herein.
	California Chrome Company	.....	.....	.....	See Little Castle Creek, herein.
	Castle Crags Chrome Company	.....	.....	.....	See Castella Mining and Milling Company, herein.
1	Castella Mining and Milling Company (Castle Crags Chrome Company, H.T. & J. Co., Montrose Mining and Milling Company, Strategic Minerals Exploration Company)	Sec. 16, T 38 N, R 4 W, MDB&M	.....	.....	(O'Brien 43:81, 327; herein.)
2	Davis group (Ida, Shiloah Springs)	Sec. 24, T 37 N, R 5 W, MDB&M	State of California.....	.....	2 mi. SW of Sims. Small tonnage mined prior to 1918. Idle. (Bradley 18:181.)
	Deick.....	T 37 N, R 5 W, MDB&M.	Undetermined.....	.....	Prospect W of Sims. No development. (Bradley 18:181, 222.)
3	Forest Queen (Black Bird, Gray Eagle, North Star, Union Forest Queen)	Sec. 22, 27, T 37 N, R 5 W, MDB&M	William Orsini, et al., Redding	.....	(Bradley 18:181–182, 222; Averill 31:116; O'Brien 43:327; herein.)
	Gill.....	.....	.....	.....	See Prim and Dougherty.
	Grafton.....	T 36 N, R 6 W, MDB&M.	Undetermined.....	.....	8 mi. NW of Lamoine. Prospect. (Bradley 18:181, 222.)
	Gray Eagle.....	.....	.....	.....	See Forest Queen, herein.
	Hearst.....	Sec. 4, T 38 N, R 4 W, MDB&M	Hearst Estate, Room 1110, Hearst Building, San Francisco	.....	About 4 mi. N of Castella. A few tons shipped by lessees in 1917. Idle. (Bradley 18:183.)
	H.T.&J. Company.....	.....	.....	.....	See Castella Mining and Milling Company, herein.
	Holden.....	Sec. 22, T 37 N, R 5 W, MDB&M	Ralph L. Smith Lumber Company, Anderson	.....	About 4 mi. NW of Gibson. 8 claims slightly developed. (Aubury 06:271; Brown 16:755.)
	Hoy group.....	Sec. 15, T 37 N, R 5 W, MDB&M	Ralph L. Smith Lumber Company, Anderson	.....	About 4 mi. W of Sims. Prospect developed in 1918. Idle. (Bradley 18:183.)
	Hull & Jones.....	T 37 N, R 4 W, MDB&M.	Undetermined.....	Deposit more than 20 ft. thick....	On Shotgun Creek. Several carloads shipped prior to 1896. Idle. (Crawford 96:50.)
	Ida.....	.....	.....	.....	See Davis group.
4	Little Castle Creek (Brown, California Chrome Company)	Sec. 2, T 38 N, R 4 W, MDB&M	Mernice Johnson, Box 897 South Highway, Dunsmuir; leased to H. T.&J. Company.	.....	(Brown 16:755; Bradley 18:183–188; Averill 39:116; O'Brien 43:81, 327; Matson 49; herein.)
	Lone Pine.....	Sec. 13, T 37 N, R 5 W, MDB&M	Ralph L. Smith Lumber Company, Anderson	.....	About 2 mi. W of Sims. Prospect. No recorded production. (Bradley 18:188.)
5	Lucky Strike.....	Sec. 7, T 38 N, R 4 W, MDB&M	Phillip Munko and L. D. Taylor, Dunsmuir	Disseminated and banded chromite in massive dunite.	Prospect about 4 mi. W of Castella. A few tons sorted ore mined in 1943 from open cut 75 ft. long in N 30° W direction. (O'Brien 43:327.)
	Miles and Westover.....	Sec. 14, 24, T 37 N, R 5 W, MDB&M	Undetermined.....	.....	Near Sims. Prospect. Idle. (Bradley 18:188.)
	Miller.....	T 38 N, R 4 W, MDB&M.	Undetermined.....	.....	Near Gibson siding. Some ore shipped in 1918 from 4 or 5 claims. Idle. (Bradley 18:188.)
	Montrose Mining and Milling Company	.....	.....	.....	See Castella Mining and Milling Company, herein.
	Noble Electric Steel Company	.....	.....	.....	See Prim and Dougherty.
	North Star.....	.....	.....	.....	See Forest Queen, herein.

CHROMITE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
6	Prim and Dougherty (Gill, Noble Electric Steel Company, Shotgun Creek Mines)	Sec. 13, 24, T 37 N, R 5 W, MDB&M	Minarets Holding Corporation, c/o Ralph L. Smith Lumber Company, Anderson	Lenses of chromite were opened up at intervals for 1,000 ft. in a NE direction. Yielded about 3,000 tons chromite prior to 1906. Diller reports assay of 43.87% Cr_2O_3, 15.86% total iron as FeO.	On Shotgun Creek about 2 mi. SW of Sims. Active 1903 and probably earlier. 3 claims operated by Noble Electric Steel Co. 1917–18. Developed by open pits and 50-ft. adit with 30-ft. vertical winze. Idle. (Diller 04:177-178; 06:14; Aubury 06:270-271; Brown 16:755; Bradley 18:188.)
7	Round Bottom (Beegum Chrome)	Sec. 5, T 28 N, R 10 W, MDB&M	Dave Pierson, Igo, and Leland Pierson, Red Bluff	.....	(O'Brien 43:81, 327; herein.)
	Shiloah Springs	.....	.....	.....	See Davis group.
	Shotgun Creek Mines	.....	.....	.....	See Prim and Dougherty.
	Sperry	T 36 N, R 5 W, MDB&M.	Undetermined	.....	On Shoemaker Mountain near Lamoine. Prospect. Idle. (Bradley 18:188.)
	Strategic Minerals Exploration Company	.....	.....	.....	See Castella Mining and Milling Company, herein.
	Union Forest Queen	.....	.....	.....	See Forest Queen, herein.

COPPER

8	Afterthought	Sec. 10, 11, 15, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Co., 1206 Pacific Mutual Building, Los Angeles 4	.....	(Crawford 94:377; Aubury 02:92–93; Diller 04:176; 06:13; Aubury 08:102–105; Brown 16:760–761; Tucker 22:595–598; 24:425–426; 26:143–144; Averill 39:123; O'Brien 48:355–356; 51:370; Albers 53:1–18; Goodwin 57:684; Albers and Robertson 61:80–88; herein.)
9	Akers group	Sec. 6, 7, T 33 N, R 5 W, MDB&M	Nannie Schonrock, Box 2768, Buckeye Route, Redding	Small lenses massive pyrite with some chalcopyrite and bornite in fractured rhyolitic dikes in greenstone. Ore said to carry $2/ton in gold and silver, and locally 2% to 6% copper. Small production.	In Squaw Creek canyon 3 mi. NW of Shasta Dam. Developed by 5 adits. Idle. (Laizure 21:516; Tucker 24:426–427; 26:144–145; Kinkel et al. 56:102.)
	Arps group	Sec. 20, 21, 28, T 34 N, R 3 W, MDB&M	United States Government.	Small lenses chalcopyrite with pyrite, sphalerite, some galena, and barite gangue; surface material contains some free gold.	About 1 mi. S of Bully Hill Mountain. Active early 1900s. 15 patented claims developed by surface cuts, 6 adits, 2 shafts, and 3,000 ft. of workings, mostly caved. Idle. (Aubury 02:96; Diller 04:175; Aubury 08:110; Brown 16:761; Tucker 23:89–90; 24:427; 26:145; Averill 33:7.)
	Asher	Sec. 2, T 33 N, R 2 W, MDB&M	.....	Disseminated sphalerite and galena in vertical fault striking N 10° E, in Pit Fm.	2 mi. NE of Ingot. Short adit, inclined shaft. No production. (Albers and Robertson, 61:88.)
	Atascadero	.....	.....	.....	See Greenhorn, herein.
	Backbone Gold Mining Company	.....	.....	.....	Operated 50-ton Mace furnace for short time in 1937 on ore mined from the Golinsky mine, which see.
10	Balaklala group (Windy Camp)	Sec. 11, 12, 13, 14, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	.....	(McGregor 90:633–634; Crawford 94:245; 96:61, 349–350; Aubury 02:84–86; Diller 03:132; 04:173; 06:13; Aubury 08:88–94; Brown 16:761–762; Laizure 21:516; Tucker 22:138; 23:8; 24:427–428; 26:145–146; Averill 33:7–8; 34:305; 39:126; Kinkel et al. 56:102–107; herein.)
	Bald Eagle	Sec. 10, T 34 N, R 3 W, MDB&M	United States Government.	Ore similar to that of Bully Hill mine, which see herein.	About 1 mi. N. of Bully Hill. Small amount development. Idle. (Brown 16:762.)
11	Baxter-Winthrop (Copper City)	Sec. 21, 28, T 34 N, R 3 W, MDB&M	Glidden Company, Union Commerce Building, Cleveland, Ohio	Massive sulfide ore lenses in vertical shear zone that strikes N 20° E, cuts E limb of anticline in Bully Hill Rhyolite. Yielded 250 tons ore assaying 8% copper, $40 gold, $20 silver in 1863, 119 tons sulfide ore in 1926–27. Favorable mineralization, large area untested ground.	About 2 mi. SW of Bully Hill. First mined 1862, and ore shipped to Wales for reduction. Developed by 3,000 ft. of adits and 1,000 ft. of drifts, shafts, and raises; ore body above Winthrop adit was stoped to surface. Idle. (Diller 04:175; 06:13; Aubury 08:107; Tucker 24:428; 26:146; Albers and Robertson 61:100.)
	Bismark	.....	.....	.....	See Jaegel.
	Black Diamond group	Sec. 2, 3, T 33 N, R 4 W, MDB&M	Jesse L. Brown, Box 2784, Buckeye Route, Redding	Irregular masses of chalcopyrite, pyrrhotite, and magnetite at contact of McCloud Limestone and quartz-augite diorite. Material assaying 8% copper reportedly encountered 1901 or 1902. Mineralization occurs in masses a few inches in diameter scattered locally in gangue of garnet and hedenbergite, and sparsely disseminated in adjacent limestone.	On S slope Gray Rocks about 12 mi. NE of Redding. Active prior to 1902. Explored by open cuts, short adits, and main adit about 2,000 ft. long. Long idle. (Aubury 02:94; Diller 03:130; 06:13; Aubury 06:304; 08:108; Tucker 24:428; 26:148.)
	Blue Jacket	Sec. 25, T 34 N, R 4 W, MDB&M	United States Government.	Copper- and iron-bearing deposit 4 ft. wide between limestone and porphyry; strikes NE, dips 30°N.	Near junction Pit and McCloud Rivers. Developed in 1896. (Crawford 94:69.)

COPPER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Bohemotosh	Sec. 25, T 34 N, R 6 W, MDB&M	Undetermined	Extensive gossan and disseminated sulfides.	About 1½ mi. SW of Bohemotosh Mountain. (Aubury 02:88; 08:97.)
	Brushy Canyon group	Sec. 34, T 34 N, R 3 W, MDB&M	United States Government	Lenses of limonite up to 10 ft. wide and several hundred feet long, derived from sulfide that had replaced siliceous metavolcanic beds in an interbedded metavolcanic-siliceous shale sequence. Copper and zinc but no lead in limonite.	3 mi. S of Bully Hill. Explored by 300-ft. adit. Idle. (Aubury 02:92; 08:102; Brown 16:763; Tucker 24:428–429; 26:146; Albers and Robertson 61:88.)
12	Bully Hill-Rising Star (California Zinc Company, Delamar, Glidden Consolidated Zinc Mines, Northern Light, Shasta Zinc and Copper)	Sec. 15, 16, 21, 22, 28, T 34 N, R 3 W, MDB&M	Glidden Company, Union Commerce Building, Cleveland, Ohio		(McGregor 90:638; Fairbanks 92:33; Crawford 94:377; 96:61; Aubury 02:75–80; Diller 03: 127–130; 04:174–175; 06:12–13;Aubury 08: 78–83, 107; Brown 16:763–764; Laizure 21:519; Tucker 22:43, 410–411; 24:429–432; 26:147–148; Logan 26:213–215; Averill 39:126, 174–175; Goodwin 57:686–687, 694; Albers and Robertson 61:88–100; herein.)
	California Zinc Company				See Bully Hill, herein.
	Canyon Creek (Consolidated Copper Company)	Sec. 4, T 36 N, R 1 W, MDB&M	United States Government	Green copper minerals stain fractures a few inches wide in metavolcanic rock.	4 mi. SW of Big Bend. Adits 130 and 30 ft. long, several cuts, and trenches failed to find ore. Idle. (Averill 39:126.)
	Canyon group	Sec. 2, T 33 N, R 2 W, MDB&M	Undetermined	A little chalcopyrite shows in adit under gossan.	2 mi. NE of Ingot. Prospected by 70-ft. adit. Idle. (Aubury 08:111.)
	Chalcosa group				See Marshall and Waters.
	Chance	Sec. 21, T 34 N, R 3 W, MDB&M	Undetermined	Deposit of heavy grayish sulfides similar to those at Bully Hill, which see herein.	About 1 mi. SW of Bully Hill. Prospected by a few short adits. Idle. (McGregor 90:638; Brown 16:764.)
	Clover Creek	Sec. 29, 32, T 33 N, R 1 W, MDB&M	R. W. Byers, 2030 California Street, Redding	Adit in shear zone in metarhyolite; winze cut 7 ft. of ore containing 4.37% copper, cut off by faulting. Outcrop ¼ mi. E is heavily stained with copper oxides for width of 20 ft. along contact with diorite dike.	5 mi. SE of Ingot. Explored by adit driven 80 ft. SW; winze 9 ft. deep 20 ft. from portal. Idle. (Laizure 21:516–517.)
	Colma group	Sec. 6, T 33 N, R 5 W, & Sec. 31, T 34 N, R 5 W, MDB&M	M. E. Dittmar, et al., San Francisco	3-ft. vein of quartz 1550 ft. from portal heavily mineralized with chalcopyrite and pyrite.	4 mi. NW of Shasta Dam. No. 5 adit of Uncle Sam gold mine, which see herein, driven in search of extension of Mammoth mine ore bodies in Colma ground. Idle. (Laizure 21:432; Tucker 23:90; 26: 148.)
	Complex				See Iron Mountain, herein.
	Congress group	Sec. 4, T 33 N, R 2 W, MDB&M	Henry A. Cook estate et al., San Francisco		1 mi. NW of Ingot. A series of adits total 430 ft. No production recorded. Idle. (Aubury 08:111.)
	Consolidated Copper Company				See Canyon Creek.
	Cook	Sec. 10, T 33 N, R 2 W, MDB&M		2 quartz veins. Principal vein 12–15 in. wide; strikes N 15°W, dips 25°W.	NE of Ingot. 2 adits, 2 pits. Possibly some production. (Albers and Robertson 61:100.)
	Copper City				See Baxter-Winthrop.
	Copper Mountain Consolidated Mining Company				See Sugar Loaf.
	Coronado Copper and Zinc Company				See Afterthought, herein.
	Cortez	Sec. 10, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Company, 1206 Pacific Mutual Building, Los Angeles	Vein up to 4 ft. wide strikes E, dips 45° S.	At Ingot. Adit 173 ft. long. Idle. (Crawford 94:70; 96:352; Brown 16:783.)
	Cowboy group	Sec. 4, T 33 N, R 2 W, MDB&M	Henry A. Cook estate et al., San Francisco	Iron-stained, weakly schistose Bully Hill Rhyolite strikes NW, dips steeply SW. Chalcopyrite in siliceous matrix on dump. Limonite contains copper, lead, zinc. Drill hole cut 13 ft. of rock containing 1.2–11.9% zinc.	About 1½ mi. NW of Ingot. 200 ft. of adits. Drilled by Coronado Copper and Zinc Co. in 1950–51. Idle. (Aubury 02:94; 08:108; Albers and Robertson 61:100–101.)
	Crystal group	Sec. 11, T 33 N, R 6 W, MDB&M	Isadore Carattini estate, c/o Emilio Silvertri, 5643 Melita Road, Santa Rosa	Bands of pyritized metarhyolite and small lenses gossan. Mineralization trends N 20° E.	4 mi. NW of Shasta Dam. Adjoins Balaklala on N. 200 ft. of adits. No production. Idle. (Aubury 08:113; Brown 16:764; Tucker 24:434; 26:151; Kinkel et al. 56:109.)
	Davidson	T 33 N, R 2 W, MDB&M.	Undertermined	Shipped ore yielded 11.4% copper, 6.8% lead.	In Ingot area. Small shipment high-grade gold-silver ore in 1913. (Goodwin 57:688.)
	De Dallis (Deodollis)	Sec. 34, T 34 N, R 3 W, MDB&M	United States Government		6 mi. NW of Ingot. In vicinity of Brushy Canyon Group, which see. Adit 420 ft. long, 8 ft. wide. (Aubury 02:92; 05:102; Brown 16:764–765; Albers and Robertson 61:88.)
	Delamar				See Bully Hill, herein.
	Deodollis				See De Dallis.

COPPER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
13	Donkey	Sec. 11, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Company, 1206 Pacific Mutual Building, Los Angeles	Small amount sulfides along narrow shear zone in Bully Hill Rhyolite 300 ft. from contact with Pit Fm. Zone strikes W, dips 75° S. Ore contains copper, zinc, lead, gold, silver. Smelter recovery 1913 averaged 5.20% lead, 3.04% copper, 17.62 oz./ton silver, 0.065 oz./ton gold. Drilling revealed sparsely disseminated sulfides.	Just E of Ingot. About 300 tons high-grade sulfide ore shipped prior to 1900; idle by 1900; some ore shipped 1913. Shear zone drilled 1951 by Coronado Copper and Zinc Co. Short adits and 200-ft. shaft with 550 ft. of drifts. Idle. (Aubury 02:93; Diller 06:13; Aubury 08:105–106; Brown 16:765, 809; Tucker 24:432; 26:148; Goodwin 57:689.)
	Dozier	Sec. 13, T 33 N, R 5 W, MDB&M	Ernest Dozier estate, Olinda	Large gossan near ridge summit. Copper sulfate on walls of adit.	About 1½ mi. NE of Shasta Dam. Adit 170 ft. long. Idle. (Laizure 21:517–518.)
14	Early Bird	Sec. 10, 11, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah		(Eric 48:330; Kinkel et al. 56:80, 109–113; herein.)
15	Friday-Louden	Sec. 5, 6, T 33 N, R 5 W, MDB&M	U.S. Smelting, Refining and Mining Company, Salt Lake City, Utah	Oxide ore carried considerable gold. Small chalcopyrite orebody with barite(?) gangue.	About 2½ mi. NW of Shasta Dam. 1,000 ft. of adits. See also Mammoth mine, herein. (Aubury 02:86–87; Diller 06:14; Aubury 08:94–95; Brown 16:765; Tucker 24:434; 26:151.)
	Galvin				See Sugar Loaf.
	Giant Consolidated (Motion Creek group, Trinity Copper Company)	Sec. 23, 24, 25, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah		3½ mi. SW of Shasta Dam. Prospect, including 23 patented claims. Open cuts, 310-ft. adit. Idle. (Aubury 02:81; 08:85; Brown 16:765.)
	Glidden Consolidated Zinc Mines				See Bully Hill, herein.
	Gold Belt group	Sec. 4, T 33 N, R 2 W, MDB&M	United States Government	Copper sulfides and some gold, silver, zinc.	2 mi. W of Ingot. Prospect. Idle. (Aubury 08:111; Brown 16:765.)
16	Golinsky (Backbone Gold Mining Company)	Sec. 28, T 34 N, R 5 W, MDB&M	United States Government	Small steeply-dipping lenses of massive sulfide, in shear zone that strikes N 60° E and dips 60° S, just above gently-dipping contact between porphyritic and non-porphyritic metarhyolite. Overlying gossan assayed 0.36 oz. gold, 8.10 oz. silver, 1.20% copper, and trace of zinc. 6,267 tons ore yielded 964 oz. gold, 25,313 oz. silver, 311,438 lbs. copper; zinc in 3,078 tons averaged 8.9%.	About 2 mi. SE of Bohemotosh Mountain. Active prior to 1902; produced during 1900s and 1930s. Several adits, one 800 ft. long; 400 ft. of drifts, one stope. Idle. (Aubury 02:90; Diller 04:174; 06:14; Aubury 08:100; Brown 16:766; Tucker 24:432; 26:149; Averill 33:29; 39:124–125; Kinkel et al., 56:114–116.)
	Grab				See Stowell.
	Graham group				See Shasta Belmont.
	Great Verde (Vulcan)	Sec. 11, 12, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	Gossan derived from pyritized rock and from massive sulfide ore, in altered metarhyolite. Lower horizon of strongly pyritized rock 200 ft. below gossan.	4 mi. NW of Shasta Dam and adjacent to Shasta King mine. Active beginning about 1900; no production. Short adits and 1500-ft. exploratory tunnel. Idle. (Aubury 02:90; 08:98–100; Brown 16:766; Kinkel, et al., 56:116–117.)
17	Greenhorn (Atascadero, Warren Brothers, Willow Creek Mines)	Sec. 5, 6, T 32 N, R 7 W, & Sec. 31, 32, T 33 N, R 7 W, MDB&M	Greenhorn Mining Company, c/o Wayne Alwood, P.O. Box 188, Springfield, Oregon		(Laizure 21:518; Tucker 24:433; 26:149; Grant 32; Averill 33:30; 39:126–127; Goodwin 57:690; Albers, 65:35–36; herein.)
	Gregory and Whalen (Oom Paul)	Sec. 25, T 35 N, R 5 W, MDB&M	United States Government	Gossan outcrop 30–40 ft. wide	About 3 mi. S of Lakehead. Undeveloped. Idle. (Aubury 02:90; 08:100.)
	Happy Jack				See Mountain Monarch.
	Hartford group	Sec. 24, T 35 N, R 2 W, MDB&M	United States Government	Copper oxides and carbonates in deposit 8 ft. wide and 100 ft. long at surface.	About 7 mi. NW of Montgomery Creek. 500 ft. of adits. Idle. (Aubury 02:93; 08:108; Brown 16:766.)
	Hornet				See Iron Mountain, herein.
	Horse Mountain group	Sec. 18, T 34 N, R 3 W, MDB&M	Undetermined	Native copper disseminated in metarhyolite.	On W slope Horse Mountain, W of Bully Hill. Idle. (Aubury 08:112.)
	Indiana and Last Chance	Sec. 19, 20, 29, T 33 N, R 5 W, MDB&M	Shasta Minerals and Chemical Co., 826 S. Main St., Salt Lake City, Utah	Sulfide ore with some high-grade oxides on surface.	About 2½ mi. SW of Shasta Dam. Several hundred ft. adits and drifts. Small production. Idle. (Crawford 96:359; Brown 16:766.)
	Ingersoll				See Peerless.
18	Iron Mountain (Complex, Hornet, Lost Confidence, Mattie, Mountain Copper Company, Ltd., No. 8, Old Mine, Richmond)	Sec. 26, 27, 33, 34, 35, 36, T 33 N, R 6 W, MDB&M	The Mountain Copper Company, 100 Mococo Road, Martinez		(Irelan 88:566–567; McGregor 90:633; Fairbanks 93:46; Crawford 94:377; 96:62; Aubury 02:66–74; Diller 03:131–132; 06:13; Aubury 08:70–78; Brown 16:769–770; Laizure 21:525–526; Tucker 24:423, 439–445; 26:154–160; Averill 31:129–138; 33:38–39; 38:312–330; 39:145, 159, 169–170; O'Brien 43:82, 327; 48:356–357; 51:370; Kett 47:105–162; Kinkel and Albers 51:1–19; Kinkel et al., 56:79, 80, 117–129; Goodwin 57:691; Sandberg, in press; herein.) See also under gold and pyrite, herein.
	Jaegel (Bismark)	Sec. 3, T 33 N, R 4 W, MDB&M	Jesse L. Brown, Box 2784, Buckeye Route, Redding		At Gray Rocks, 18 mi. N of Redding. Undeveloped prospect. Idle. (Aubury 02:95; 08:109.)

COPPER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
19	J C L	Sec. 8, T 31 N, R 5 W, MDB&M	Raymond F. Leonard, Box 1451, Redding		Herein.
	Jumping Jack	Sec. 24, 25, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah		On the E slope of Sugar Loaf Mountain, 400-ft. adit. Idle. (Aubury 02:81; 08:85; Brown 16:766–767.)
	Kane				See Keane.
	Kane and Wilbur group	Sec. 24, T 34 N, R 4 W, MDB&M	United States Government.	Deposit of magnetite, pyrrhotite, chalcopyrite, and pyrite in meta-andesite; vein 6 to 10 ft. wide.	About 1 mi. NE of junction Pit and McCloud Rivers. 40-ft. shaft, 50-ft. adit, and 200-ft. drift. Idle. (Tucker 23:92–93.)
	Keane (Kane)	Sec. 4, T 36 N, R 3 W, MDB&M	Undetermined	Narrow veins of copper sulfides	About 1 mi. SW of Hat Mountain and 10 mi. W of Gibson. 7 adits 20 to 135 ft. long. Idle. (Tucker 26:149–150.)
	Keith group				See Shasta May Blossom.
20	Keystone	Sec. 13, 14, T 33 N, R 6 W, MDB&M	United States Smelting, Refining and Mining Company, 921 Newhouse Building, Salt Lake City, Utah	Massive sulfide orebodies in productive zone 300 ft. thick, below gently-dipping contact between middle and upper units of Balaklala Rhyolite. Copper-rich ore occurs in separate tabular bodies and as part of large pyritic masses, and usually is bounded by strong shear zones. 122,000 tons ore averaged 0.06 oz. gold, 2.7 oz. silver, 6.0% copper, 8.0% zinc.	About 4½ mi. W of Shasta Dam; Balaklala mine adjoins on S and Stowell mine on E. Explored in 1900s, 1918; producer 1923–25. 2 adits driven SW with 2,000 ft. of drifts and crosscuts. Idle. (Aubury 02:90; 08:100; Tucker 23:8; 24:435; 26:151; Kinkel et al. 56:55, 129–131.)
	King Copper group	Sec. 23, 24, 25, 26, T 33 N, R 6 W., MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	Small lenses of gossan occur in pyritized and hydrothermally altered metarhyolite. Largest lens 50 ft. long and 2 ft. thick at surface; dips gently N.	3 mi. W of Matheson; Sugar Loaf mine adjoins on S. 1,000 ft. of adits by 1902. No production. Idle. (Aubury 02:81; Diller 06:13; Aubury 08:84–85; Tucker 24:447; 26:162; Kinkel et al. 56:131–132.)
	Kosh				See Kosk Creek.
	Kosk Creek (Kosh)	Sec. 23, T 37 N, R 1 W, MDB&M	Undetermined	Globules and films of native copper in joints and vesicles in dark basaltic rock in zone 200 ft. wide.	3 mi. NW of Big Bend. Short adit, shaft. Idle. (Aubury 02:93; 08:108; Crawford 96:63; Brown 16:767; Tucker 24:433; 26:150.)
	Little Nellie	Sec. 27, 35, T 33 N, R 6 W, MDB&M	Mountain Copper Company, 100 Mococo Rd., Martinez	3 parallel quartz veins 2–4 ft. wide strike NE and dip N in quartz diorite. Small lenses of pyrite with chalcopyrite, but no large orebodies.	3 mi. W. of Matheson; SE of Iron Mountain mine. Worked in "early days" for gold, later for copper. Several thousand ft. of adits and winzes. See also under gold. (McGregor 90:634–635; Tucker 24:433–434; 26:150.)
21	Lone Star	Sec. 27, T 33 N, R 6 W, MDB&M	Mountain Copper Company, 100 Mococo Rd., Martinez	Small, flat-lying, faulted, massive-sulfide orebody in prophyritic Balaklala Rhyolite. Ore is sphalerite and chalcopyrite in massive pyrite, with little gangue. Copper assays range from 0.62–6.89%, average 3.74%.	NW of Iron Mountain. 2 short adits. Diamond-drilled by Mountain Copper Co. prior to 1952. No production. (Kinkel et al. 56:132.)
	Loraine (McKinley Consolidated.)	Sec. 7, 18, T 33 N, R 5 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah		3 mi. NW of Shasta Dam. 425-ft. adit, several short crosscuts. Idle. (Aubury 02:82; 08:87; Brown 16:767.)
	Lost Confidence				See Iron Mountain, herein.
	Lost Desert				See Shasta King, herein.
22	Mammoth	Sec. 32, T 34 N, R 5 W, MDB&M	United States Smelting, Refining and Mining Company, 921 Newhouse Building, Salt Lake City, Utah		(Aubury 02:87–88; Diller 04:174; 06:13–14; Aubury 08:95–97; Brown 16:767–769; Tucker 22:296; 24:435–436; 26:150–151; Averill 39:141, 175, 191; Kinkel and Albers 51:1–19; Kinkel et al, 56:133–138; Goodwin 57:692; herein.)
	Marshall and Waters (Chalcosa group)	Sec. 14, 15, 22, 23, T 33 N, R 6 W, MDB&M	Shasta Copper Exploration Co., Belding Building, Stockton		5 mi. W of Shasta Dam; adjacent to Stowell mine. 400-ft. adit. Idle. (Aubury 02:82; 08:85; Brown 16:769.)
	Mattie				See Iron Mountain, herein.
	McCloves	Sec. 10, T 34 N, R 3 W, MDB&M	Undertermined		Just N of Bully Hill mine. Idle. (Tucker 26:139.)
	McClure				See Pioneer.
	McKinley Consolidated				See Loraine.
	Memorial	Sec. 15, 22, T 33 N, R 4 W, MDB&M	Undetermined	Some sulfide mineralization	About 4 mi. NE of Project City. 11 unpatented claims. Idle. (Aubury 02:95; 08:109; Tucker 26:139.)
	Michigan group	Sec. 16, 21, T 34 N, R 3 W, MDB&M	W. K. Potts, 2090 Pacific Ave., San Francisco	Some high-grade ore	Just W of Bully Hill mine. Explored by adits and drifts. Idle. (Aubury 02:95; 08:109; Tucker 26:139.)
	Mineral Mountain	Sec. 13, T 32 N, R 6 W, MDB&M	Undetermined	Sulfide mineralization	About 1½ mi. W of Keswick. 300-ft. adit. Idle. (Aubury 02:80–81; 08:84; Brown 16:769.)

COPPER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Minnie Haley group	Sec. 24, T 34 N, R 4 W, MDB&M	Undetermined	Chalcopyrite associated with pyrite and some gold and silver.	About 1 mi. NE junction Pit and McCloud Rivers. 4 adits 20–150 ft. long. Idle. (Tucker 23:92; 24:439; 26:154.)
	Morris	Sec. 10, T 34 N, R 3 W, MDB&M	Undetermined	Ore similar to that of Bully Hill mine, which see herein.	About 1 mi. N of Bully Hill. 2 adits 400 and 80 ft. long. Idle. (Brown 16:769.)
	Motion Creek group				See Giant Consolidated.
	Mountain Copper Company, Ltd.				See Iron Mountain, herein.
	Mountain Monarch (Happy Jack)	Sec. 28, 33, T 32 N, R 6 W, MDB&M	Hugh Shuffleton, Jr., 2078 Butte Street, Redding	Zone of malachite 5 ft. wide on surface, in meta-andesite near contact with quartz diorite. Dump contained crystalline pyrite with some chalcopyrite and covellite.	4 mi. W of Shasta. 700-ft. crosscut adit failed to reach orebody. Idle. (Ferguson 14:49; Brown 16:770; Laizure 21:522; Tucker 24:445; 26:160; Averill 33:31.)
	Northern Light				See Bully Hill, herein.
	No. 8				See Iron Mountain, herein.
	Ohio Consolidated	Sec. 12, T 33 N, R 6 W, MDB&M	Shasta Minerals and Chemical Company, 826 S. Main St., Salt Lake City, Utah	Pyrite mineralization	About 3 mi. NW of Shasta Dam. Several adits, one 530 ft. long. Idle. (Aubury 02:86; 08:94; Brown 16:770; Tucker 24:445; 26:160.)
	Old Mine				See Iron Mountain, herein.
	Oom Paul				See Gregory and Whalen.
	Oregon Consolidated	Sec. 13, 14, T 33 N, R 6 W, MDB&M	U.S. Smelting, Refining and Mining Company, 921 Newhouse Building, Salt Lake City, Utah	Sulfide mineralization of undetermined extent.	4 mi. W of Shasta Dam. Several adits totaling about 1,500 ft. Idle. (Aubury 08:113–114; Brown 16:770.)
	Pacific Mineral Corporation				Constructed leaching plant at Kennett in 1926 to recover copper and zinc oxide from Mammoth smelter flue dust. Operation short lived. (Tucker 26:216.)
	Peerless (Ingersoll)	Sec. 25, 26, T 33 N, R 6 W, MDB&M	Undetermined	Heavy gossan similar to that on Giant Consolidated property.	2 mi. W of Matheson. 350-ft. drift, 190-ft. crosscut. Idle. (Aubury 08:114; Brown 16:766.)
	Pioneer (McClure)	Sec. 9, 16, T 34 N, R 3 W, MDB&M	Delores Thomas, 498 S. Fifth Street, San Jose	Ore contains gold, silver, copper.	At Bully Hill, adjacent to Bully Hill mine. Crosscut adit 500-ft. long. Idle. (Aubury 02:96; 08:110–111; Brown 16:769; Tucker 24:438–439; 26:154.)
	Pit River	Sec. 25, T 34 N, R 3 W, MDB&M	Southern Pacific Land Company, San Francisco	Oxide ore on surface carried gold.	2 mi. SE of Bully Hill. 500-ft. adit. Small producer prior to 1914. Idle. (Brown 16:770–771.)
	Polkingham	Sec. 11, T 33 N, R 2 W, MDB&M	State of California	Little ore showing; some gold in oxidized zone.	1 mi. S of Ingot. 100-ft. shaft. Idle. (Aubury 08:111; Brown 16:771.)
	Popejoy	Sec. 16, 21, T 34 N, R 3 W, MDB&M	Glidden Company, Union Commerce Building Cleveland, Ohio	Base-metal ore similar to that of Bully Hill mine, which see herein.	At Bully Hill. Prospected by several short adits. Idle. (Brown 16:771.)
	Reno	Sec. 20, T 34 N, R 4 W, MDB&M	Undetermined	"A little copper ore"	About 1½ mi. SW of O'Brien. Some shafts and adits. No production. Idle. (Aubury 08:113.)
	Reynolds	Sec. 10, T 33 N, R 6 W, MDB&M	Undetermined		4 mi. W of Shasta Dam, adjacent to Balaklala mine. Idle. (Aubury 08:114.)
	Richmond				See Iron Mountain, herein.
	Rising Star				See Bully Hill, herein.
	Roseman group	Sec. 3, T 33 N, R 4 W, MDB&M	Jesse L. Brown, Box 2784 Buckeye Route, Redding	Copper oxide and carbonate near surface, sulfides at depth. Occurs in shear zone adjacent to limestone.	At Gray Rocks, 5 mi. N of Project City. Several hundred feet of adits, shafts, and winzes. Idle. (Aubury 02:94–95; 08:109; Brown 16:771.)
	Shasta Belmont (Graham group)	Sec. 24, T 34 N, R 4 W, MDB&M	United States Government	Narrow orebody in E-trending fault in meta-andesite. Ore chiefly chalcopyrite and chalcocite in pyrite with quartz gangue. 3 cars ore averaging 7% copper and 4 oz. silver reportedly shipped to Mammot smelter.	On Horse Mountain, 4 mi. W of Bully Hill. 350- and 225-ft. adits connected by raise; 75-ft. shaft. Idle. (Aubury 08:113; Tucker 24:445; 26:160.)
	Shasta Copper and Uranium Company				See Walker Corporation group.
	Shasta Kennett group	Sec. 35, T 34 N, R 5 W, MDB&M	United States Government	Iron and copper sulfides in vein	3 mi. N of Shasta Dam. 470-ft. main adit; 230 ft. of workings. Idle. (Aubury 08:114.)
23	Shasta King (Lost Desert, Trinity)	Sec. 11, 12, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah		(Aubury 02:82–84; Diller 03:132; 04:173–174; 06:13; Aubury 08:87–88; Brown 16:771; Tucker 24:445–446; 26:160–161; Kinkel and Hall 51: 1–11; Kinkel et al. 56:24, 25, 138–144; herein.)
24	Shasta May Blossom (Keith group)	Sec. 14, 15, T 34 N, R 3 W, MDB&M	United States Government	Dense layers limonite gossan up to 20 ft. thick each, interlayered with silicified shale and quartz keratophyre of Pit Fm. and	About 1 mi. E of Bully Hill. Several open cuts and 7 adits totaling 2,000 ft. prior to 1908. Diamond drill hole put down, 1921. No production. Idle. (Aubury 02:92; 08:100–102; Brown 16:772;

COPPER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Shasta May Blossom —Continued			Bully Hill Rhyolite. Pyrite with some chalcopyrite in calcite on dumps. Ore shoot 40 ft. long, 4–6 ft. wide, said to contain 6% copper, $8/ton in gold and silver.	Tucker 23:91; 24:446; 26:161; Albers and Robertson 61:101–102.)
	Shasta Minerals and Chemical Co.	.....	.....	.....	See Walker Corporation group.
	Shasta National Copper Company	Sec. 18, 19, 20, T 34 N, R 5 W, MDB&M	Undetermined.....	.....	On N slope Bohemotosh Mountain. 38 claims N of Mammoth group. Several adits. Idle. (Tucker 24: 446; 26:161.)
	Shasta-Phelps Dodge Joint Venture	.....	.....	.....	See Walker Corporation group.
	Shasta Zinc and Copper Company	.....	.....	.....	See Bully Hill, herein.
	Skookum.....	Sec. 11, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	.....	5 mi. W of Shasta Dam. 6 patented claims. Idle. See also Walker Corporation group.
	Slaughter group.....	Sec. 26, T 34 N, R 3 W, MDB&M	Undetermined.....	Ledge 30 ft. wide.....	About 1½ mi. SE of Bully Hill. 70-ft. adit. Idle. (Aubury 08:112.)
25	Spread Eagle group.....	Sec. 13, T 33 N, R 6 W, MDB&M	U.S. Smelting, Refining and Mining Company, 921 Newhouse Building, Salt Lake City, Utah	Workings near gradational contact between upper and middle units of Balaklala Rhyolite. Heavily pyritized, steeply dipping shear zones explored at depth; lack of stopes indicates minable ore not found. Mineralization is pyrite with minor chalcopyrite. Gossan over massive, near-surface sulfide orebody contains gold ranging from trace to 0.575 oz/ton.	4 mi. W of Shasta Dam; about 1 mi. SE of Balaklala mine. Active prior to 1902 and during 1900s. 10 adits; workings total 3,000 ft. (Aubury 02:82; Diller 04:173; 06:13; Aubury 08:85–87; Brown 16:772; Tucker 24:436; 26:152; Kinkel et al. 56:144–146.)
	Stauffer Chemical Company	.....	.....	.....	See Summit group.
	Stevenson.....	Sec. 14, T 33 N, R 6 W, MDB&M	U.S. Smelting, Refining and Mining Company, 921 Newhouse Building, Salt Lake City, Utah	.....	About 4½ mi. W of Shasta Dam. Short adits and open cuts. Idle. (Brown 16:772.)
26	Stowell (Grab, Webster Consolidated)	Sec. 14, T 33 N, R 6 W, MDB&M	U.S. Smelting, Refining and Mining Company, 921 Newhouse Building, Salt Lake City, Utah	3 lenses of massive sulfide in Balaklala Rhyolite yielded 39,538 tons ore containing 0.03 oz. gold, 1.09 oz. silver, 3.0% copper. Zinc present in dump material. Large gossan above main adit portal contains up to 0.2 oz. gold.	About 4½ mi. W of Shasta Dam. Active prior to 1902, producer 1916–19. Main adit 1300 ft. long; several hundred ft. drifts, winzes. (McGregor 90:633; Crawford 96:364–365; Aubury 02:82; 08:85; Brown 16:772; Tucker 24:436; Kinkel et al. 56:146–149.)
	Sugar Loaf (Copper Mountain Consolidated Mining Company, Galvin)	Sec. 25, 26, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	Quartz and siliceous metarhyolite contain 20–75% pyrite, generally in coarse cubes not typical of massive sulfide orebodies. No massive sulfide found.	2 mi. W of Matheson. 1300 ft. of adits by 1902; 12 adits totalled 4,365 ft. by 1908. Idle. (Aubury 02:81; 08:84; Brown 16:772; Kinkel et al. 56: 149.)
	Sulphide.....	Sec. 16, T 32 N, R 6 W, MDB&M	Undetermined.....	Low-grade sulfides carry a little gold.	Near Whiskeytown. Short adit. Idle. (Brown 16:773.)
	Summit group.....	Sec. 30, T 34 N, R 5 W, MDB&M	Albert Walter, c/o Stauffer Chemical Company, 636 California Street, San Francisco	Metarhyolite and minor slate country rock. Ore consists of indistinctly banded chalcopyrite with some pyrite.	About 4½ mi. NW of Shasta Dam; adjoins Mammoth mine. Active intermittently from prior to 1902 until mid-1910s. 3 adits, one 400 ft. long with 350-ft. raise. Idle. (Aubury 02:88–90; Diller 04:174; 06:14; Aubury 08:97–98; Brown 16:773; Tucker 24:447; 26:162.)
27	Sutro.....	Sec. 29, 30, T 34 N, R 5 W, MDB&M	U.S. Smelting, Refining and Mining Company, 921 Newhouse Building, Salt Lake City, Utah	Massive sulfide orebodies below contact between middle and upper units Balaklala Rhyolite yielded 35,300 tons ore containing 0.08 oz. gold, 6.40 oz. silver, 7.54% copper.	About 4 mi. NW of Shasta Dam. Includes old Sutro mine and Summit group, which see. Active around 1908, producer 1913–18, 1923–25. 6 adits, one 2,000 ft. long, extensive drifting. Idle. (Tucker 23:8; 24:436–437; 26:152; Kinkel et al. 56:149–151.)
28	Thompson (Wallis).....	Sec. 34, T 33 N, R 4 W, MDB&M	Bessie A. Wallis, Box 2862, Buckeye Route, Redding	.....	(Averill 39:153–154; herein.)
	Trinity.....	.....	.....	.....	See Shasta, King, herein.
	Trinity Copper Company ..	.....	.....	.....	See Giant Consolidated.
	U.S. Smelting, Refining and Mining Company	.....	.....	.....	See Keystone, Mammoth, Spread Eagle, Stowell, and Sutro.
	Vulcan.....	.....	.....	.....	See Great Verde.
	Walker Corporation group.	.....	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	.....	About 4 mi. W of Shasta Dam. Includes Balaklala, Early Bird, Great Verde, Indiana and Last Chance, Jumping Jack, King Copper, Lorraine, Shasta King, Skookum, Sugar Loaf, and other patented and unpatented claims in the West Shasta Copper belt. In October 1954, these claims were leased to the Shasta Copper and Uranium Company, which was reorganized shortly thereafter to form the Shasta

COPPER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Walker Corporation group —Continued				Minerals & Chemical Co. From 1955 to 1957, the Shasta-Phelps Dodge joint venture explored the properties, using geological and geophysical mapping and diamond drilling. Shasta Minerals & Chemical Co. continued drilling through 1961. In February 1961, Walker Engineering Corp. sold the properties to Shasta Minerals. 34,333 ft. of drilling in 76 holes as much as 1,760 ft. deep, but averaging 300–500 ft. deep, have been completed since 1955. (Eng. and Min. Jour. 62:250.)
	Wallis				See Thompson.
	Warren Brothers				See Greenhorn, herein.
	Webster Consolidated				See Stowell.
	Willow Creek Mines, Inc.				See Greenhorn, herein.
	Windy Camp				See Balaklala, herein.
	Woodrow Wilson	Sec. 4, T 33 N, R 2 W, MDB&M	Undetermined	2 quartz veins, carrying galena, chalcopyrite, pyrite, and sphalerite.	About 5 mi. SW of Ingot. Adjoins Afterthought mine. Developed by 2 shafts 35 ft. deep and 3 adits totaling about 1,000 ft. Idle. (Tucker 23:56; 24:477; 26:162.)

GOLD—LODE

	Accident				See Sybil.
	Acme				See Garfield.
	Advance Consolidated	Sec. 1, 2, T 35 N, R 5 W, MDB&M	Regis E. Halter, Redding	3 parallel, vertical veins 4 ft. wide. Payshoot of free milling ore 4 ft. wide, 400 ft. long. Some sulfide ore.	About 6 mi. W of Delta. 4 adits 50–1,000 ft. long with 1,000 ft. of drifts, raises, and stopes. Small production. Idle. (Brown 16:777–778.)
	Afterthought	Sec. 10, 11, 15, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Co., 1206 Pacific Mutual Building, Los Angeles 4	Yielded about 5,000 oz. gold from complex sulfide ore, 1905–52.	(Albers and Robertson 61:81.) For extended list of references, see tabulated list under copper; for additional description, see herein under copper.
29	Ajax	Sec. 28, T 33 N, R 6 W, MDB&M	August Herman and Les Ralston, Whiskeytown		(Herein.)
	Alice (Alice Consolidated)	Sec. 19, T 32 N, R 5 W, MDB&M	Anna Baker, 1917 9th Avenue, Redding	3 parallel veins up to 3 ft. wide	2 mi. N of Shasta. Adits 25, 80, and 300 ft. long. Small production prior to 1914. Idle. (Crawford, 94:245; 96:349; Brown 16:778; Laizure 21:519.)
	Alice	T 31 N, R 7 W, MDB&M	Undetermined	Quartz vein 8–30 in. wide; abundant pyrite.	6 mi. N of Ono. 150-ft. adit, 200-ft. drift. No production recorded. Idle. (Crawford 94:245.)
	Alice Consolidated				See Alice.
	Alliance	Sec. 1, T 31 N, R 5 W, MDB&M	Undetermined	Shear zone in granitic rock	5 mi. W of Redding. Adit 45 ft. long. Idle. (Crawford 96:349.)
	Alvina	T 31 N, R 5 W, MDB&M	Undetermined	Veins 3 ft. wide strike N at contact of granite and diorite; outcrops yielded coarse gold.	Near Sawmill Gulch, 4 mi. N of Horsetown. 3 shallow shafts. Idle. (Crawford 96:349.)
	Al Toland	Sec. 28, T 36 N, R 6 W, MDB&M	Undetermined	Vein 2½ ft. wide strikes NW, dips 45° SW. Payshoot 100 ft. long contained free gold; some high-grade ore produced.	About 7 mi. W of Delta. 180-ft. winze at face of 200-ft. main adit. Idle. (Brown 16:778.)
30	American	Sec. 12, 13, T 33 N, R 7 W, & Sec. 7, T 33 N, R 6 W, MDB&M	Hazel Gold Mining Company, San Francisco, Mehrle Jennings, Shasta, and John MacGinniss, French Gulch		(Irelan 88:564–565; McGregor 90:637; Crawford 94:245; 96:349, 357; Ferguson 14:60–61; Brown 16:778–779; Tucker 23:135–136; Logan 26:169; Averill 39:130–131; Kinkel et al. 56:57; Albers 65:19–21; herein.)
	American Zinc, Lead and Smelting Company		American Zinc, Lead and Smelting Company, Paul Brown Bldg., St. Louis, Missouri		Leased Uncle Sam mine, which see herein, in 1923. (Tucker 23:57.)
	Anaconda				See Sybil.
	Anavina (Peerless)	Sec. 23, T 31 N, R 6 W, MDB&M	Undetermined	3 parallel veins in greenstone strike N, dip 75° E. Pockets yielded some coarse gold.	About 2 mi. NE of Igo. 75-ft. shaft with drifts N and S at 50-ft. level; 350-ft. adit on vein. Idle. (Crawford 94:245; 96:349; Tucker 22:598–599.)
	Annie	T 32 N, R 6 W, MDB&M	Undetermined	Vein 3 ft. wide strikes E, dips 45° N; low grade ore.	2 mi. W of Shasta. Idle. (Crawford 96:349.)
	Arbuckle				See Bell Cow.
	Arndt-Haschke	Sec. 33, 34, T 34 N, R 2 W, MDB&M	Adolph and Hilda Brushett and Rile G. Eldridge, Box 14, Bella Vista	Gossan carries some gold	On N slope of Sugarloaf Mountain, 2 mi. NW of Ingot. Idle. (Laizure 21:519.)
	Atlantic	Sec. 17, 20, T 31 N, R 6 W, MDB&M	Undetermined	2 parallel veins in granitic rock. Payshoot 70 ft. long, 15 ft. wide.	About 2½ mi. NW of Igo. 440-ft. drift. Small producer. Idle. (Brown 16:779.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Aurora				See Desmond.
	Australia (New Year and Australian)	Sec. 19, 30, T 32 N, R 6 W, MDB&M	Undetermined	2 parallel veins trend W, dip 60° N, with greenstone footwall and granite porphyry hanging wall. Payshoot 60 ft. long, 4 ft. wide.	About 1½ mi. SW of Whiskeytown. 3 adits; one 340 ft. long with 40-ft. winze at face. Small production prior to 1914. Idle. (Crawford 96:362–363; Brown 16:779.)
	Baker	Sec. 27, T 34 N, R 6 W, MDB&M	Southern Pacific Land Company, San Francisco 11	Sulfide ore in irregular masses of quartz with pockets carrying free gold, in slate near contact with greenstone.	9 mi. NE of French Gulch. 2 adits 120 and 135 ft. long. Reportedly yielded $5,000 prior to 1933. Idle. (Averill 33:7.)
31	Ballou (Great Falls and Hope, Manzanita)	Sec. 7, 18, T 31 N, R 6 W, MDB&M	Roy S. Ballou, Igo	Quartz veins 2–5 ft. wide strike N 20° E, dip 80° E, in quartz diorite. Free milling ore from quartz near footwall, in oxidized zone about 75 ft. below surface. Ore milled 1875–76 said to have yielded $325/ton in gold.	4 mi. NW of Igo. 5 patented claims. Active beginning 1875, some ore milled at Chicago Consolidated mine 1875–76, and location notice filed 1877; ore subsequently worked in arrastre. Numerous adits, drifts; more than 1,500 ft. of workings. Idle since 1938. (Crawford 94:248; Brown 16:788–789; Tucker 22a:320–321; Averill 39:131–132; R. S. Ballou, p.c. 1963; Albers 65:32.)
	Banghart				See Mad Mule, herein.
	Beaver				See Woodfill.
	Bell	T 30 N, R 8 W, MDB&M.	Undetermined	Vein 4–6 ft. wide.	7 mi. W of Ono. Crosscut adit 180 ft. to vein; 500-ft. drift stoped to surface. Small producer. Idle. (Hodson 93:396; Crawford 94:245.)
32	Bell Cow (Arbuckle)	Sec. 35, T 30 N, R 9 W, MDB&M	Dee Sherwood et al., Route 3, Box 262, Orland	Parallel quartz veins strike NW, dip steeply SW, in schist.	4 mi. NE of Platina. Adits, drifts, and crosscuts total 1,053 ft. Gold was amalgamated in stamp mill. Idle. (Tucker 22:296, 493–494; Logan 26:169–170; Averill 33:10.)
33	Benson group	Sec. 12, 14, T 32 N, R 6 W, MDB&M	Dr. H. M. Falk, 2110 Magnolia St., Burbank	Vein of crushed quartz 3 ft. wide at contact between quartz diorite and greenstone strikes W, dips 70° N. Stope 25 ft. long and 10–15 ft. high yielded $1,150 in 1929; free gold accounted for ¼ of value.	2 mi. N of Shasta. Located 1922, producer 1929; active 1930s. Short adit, drift, winze. Idle. (Averill 33:10–11.)
	Betty May	Sec. 8, T 32 N, R 6 W, MDB&M	Undetermined	12-in. vein of stained, white quartz contains free gold.	2 mi. NW of Whiskeytown. Active late 1920s and 1930s. Inclined shaft 135 ft. deep, drift 100 ft. long at 100-ft. level. Idle. (Averill 33:11.)
	Big Four	T 31 N, R 6 W, MDB&M.	Undetermined	Vein 5 ft. wide in slate strikes NW.	4 mi. NW of Shasta. 60-ft. inclined shaft and open cut 150 ft. long. Idle. (Crawford 96:350.)
	Big Gem				See Boswell group.
	Billy McCormick (Jackson)	T 32 N, R 8 W, MDB&M.	Undetermined	Vein 4½ ft. wide between slate and porphyry walls.	35-ft. adit. Idle. (Crawford 96:350.)
34	Bjork group (Golden Blanket)	Sec. 6, T 33 N, R 6 W, MDB&M	Undetermined	Upper, 3-ft. quartz vein in greenstone near contact with Bragdon Fm. slate strikes W, dips 45° S. Ore of "very good" grade from lower 18-in. vein that strikes N 30° E, dips 45° W.	On the N slope Shirttail Peak. 80-ft. shaft on upper vein; lower adit and drifts total 200 ft. Idle. (Averill 39:132.)
	Black Bear	Sec. 9, T 29 N, R 10 W, MDB&M	Emilio Cromay et al.; address unknown	5-ft. vein in slate.	Near Knob. Slightly developed by 2 short adits. Idle. (Crawford 96:350, 359; Brown 16:779.)
	Black Bear	Sec. 11, T 31 N, R 6 W, MDB&M	Mrs. Mae Helene Bacon Boggs, 640 Sutter St., San Francisco		On E slope Mule Mountain. Undeveloped prospect on patented land. Idle. (Averill 33:11.)
	Black and Brown Bear	Sec. 1, T 33 N, R 6 W, MDB&M	C. O. Benson, 1610 Nerwendie St., Los Angeles	Vein 20 ft. wide strikes NE in porphyry.	About 4 mi. NW of Shasta Dam. 11 claims. Adit on vein 1,000 ft. long. 10-stamp mill. Idle. (Crawford 96:350.)
	Black Cloud and Red Cloud (Reservoir and Offset)	Sec. 15, T 32 N, R 5 W, MDB&M	Undetermined	Low-grade ore in vein 4–6 ft. wide. 100 tons from shaft averaged $3/ton.	About 2½ mi. N of Redding. 165-ft. shaft with drift 60 ft. long and 45-ft. crosscut at 100-ft. level. Idle. (Laizure 21:520.)
	Black Diamond (Grandview)	Sec. 5, T 31 N, R 5 W, MDB&M	Undetermined	Small quantity high-grade gold ore produced from vertical seam in greenstone.	About 2½ mi. SE of Shasta. Several shafts 10–50 ft. deep. Idle. (Tucker 22:296; Averill 39:132.)
	Blackfoot	T 31 N, R 6 W, MDB&M.	Undetermined	Vein 6 in. to 5 ft. wide	4 mi. S of Shasta. 45-ft. shaft with drift 40 ft. to S at bottom; stope 30 ft. high. Idle. (Crawford 94:245–246.)
	Black Hawk	Sec. 14, T 31 N, R 6 W, MDB&M	George H. Hall and Edward W. Girard; address unknown	Vein in greenstone	About 2½ mi. N of Igo. 400-ft. adit. Small producer. Idle. (Brown 16:779.)
	Black Oak group	Sec. 17, T 30 N, R 6 W, MDB&M	Alvin Hightower, Redding.		3 mi. SE of Ono. 4 quartz claims; assessment work recorded.
	Black Prince				See Diamond.
	Black Spider (Jones)	Sec. 19, T 32 N, R 5 W, MDB&M	Rosa Jones, Box 487, Redding	Quartz veins a few in. to 4 ft. wide associated with basic dikes in quartz diorite. High-grade ore at intersections of veins and dikes; one pocket of a few tons yielded $1,200.	2 mi. NE of Shasta. Old 460-ft. shaft, 420-ft. adit, and short drifts encountered little minable ore. Work in 1930s consisted of 80-ft. shaft with 40-ft. drift near bottom; 120-ft. adit into old workings required heavy timbering. Idle. (Crawford 94:246; 96:350; Brown 16:779; Averill 33:32.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Blackstone	Sec. 34, T 32 N, R 6 W, MDB&M	Undetermined	In quartz diorite. Auriferous pyrite in gangue of quartz and dolomite cut by minute threads of specularite.	2 mi. SW of Shasta; 1,200 ft. N of Mt. Shasta mine. Prospect. (Ferguson 14:49.)
	Black Tom				See Niagara group, herein.
	Blue Bird	Sec. 31, T 33 N, R 5 W, MDB&M	Ralph Butler, et al.; address unknown	Vein of milling ore 5–6 ft. wide...	½ mi. W of Matheson. 30-ft. shaft. (Averill 39:132.)
	Blue Danube	Sec. 12, T 32 N, R 6 W, MDB&M	P. I. Moriarity, Yuba City, and F. B. Johnston, Redding	Quartz veins associated with quartz diorite and alaskite porphyry contain $2–$10/ton in gold.	About 3½ mi. N of Shasta; adjoins Benson mine. Undeveloped. (Averill 33:11.)
35	Blue Gravel	Sec. 2, T 31 N, R 5 W, MDB&M	City of Redding		(Averill 33:59–60; 39:133; herein.)
	Blue Lead Mining Co.				See Niagara, herein.
	Bodie	Sec. 6, T 32 N, R 7 W, MDB&M	Undetermined	Vein with granitic walls; narrow, free-milling ore shoot 250 ft. long.	3 mi. W of Tower House. 560-ft. adit with 400 ft. of drifts and stope 110 ft. long; 40-ft. shaft. Small producer. Idle. (Brown 16:779–780.)
	Bonanza	Sec. 6, T 32 N, R 6 W, MDB&M	Undetermined	Vein with slate footwall and granite-porphyry hanging wall strikes N, dips 50° E; cut by W-trending diorite dike 20 ft. wide. Pay shoot 14 in. wide, 120 ft. long.	4 mi. NW of Whiskeytown. 3 adits at 50-ft. vertical intervals; lengths 60, 120, and 180 ft., top to bottom. Idle. (Brown 16:780.)
	Bonanza (Salt Creek group)	Sec. 32, T 32 N, R 5 W, MDB&M	Undetermined	Bonanza and Corinne veins are vertical, strike N; they are 400 ft. apart at contacts of large diorite dike intrusive into porphyry. Bonanza is 3 ft. wide, Corinne 4 ft. with 20 in. of sulfide ore exposed in adit. Steeply-dipping Jumbo vein 2 ft. wide trends W, cuts other two; contains coarse free gold. Phoenix vein E of Corinne is 2½ ft. wide, strikes N, contains coarse gold.	4 mi. W of Redding. Bonanza vein developed by 300-ft. shaft, 30-ft. adit; 135-ft. adit cut Corinne vein. Short Shaft and adit on Jumbo. Ore worked in arrastre. (Crawford 94:256; 96:364.)
	Bonanza Gold Dollar				See Shasta View.
36	Boswell group (Big Gem, Florida, Redding Consolidated of Nevada)	Sec. 7, T 31 N, R 5 W, MDB&M	C. E. Boswell, et al., 2267 35th Ave., San Francisco 16	Several quartz veins associated with andesitic dikes in quartz diorite.	6 mi. SW of Redding. Shaft 112 ft. deep cut vein at 75 ft. Another vein 300 ft. W of shaft was stoped for length of 20 ft. from 10 ft. above a drift to the surface. Gold was amalgamated. Idle. (Crawford 94:248; Laizure 21:520–521; Tucker 22:494; Averill 33:11–12; 39:133.)
	Bowery Bell	T 32 N, R 5 W, MDB&M.	Undetermined	Vein of ribbon quartz 8–11 ft. wide in granite.	2½ mi. NE of Shasta. 2 crosscut adits 75 and 400 ft. long, 100 ft. apart; 102-ft. drift from upper adit. Several shallow shafts. Idle. (Crawford 96:350–351.)
	Brackett				See Minneshasta.
	Bright Star				See first Evening Star.
	Broken Hills	Sec. 23, T 31 N, R 6 W, MDB&M	Undetermined	2 nearly-vertical quartz veins 100 ft. apart in diorite near contact with greenstone strike N. E vein 4 ft. wide, carries abundant pyrite and arsenopyrite; said to assay $4/ton. W vein 22 in. wide with similar ore; said to assay $11/ton. 6-in. quartz stringer 500 ft. S of tunnel said to have yielded $3,000.	About 1½ mi. NE of Igo. Adit driven E 400 ft. cut quartz veins at 150 and 250 ft. Idle. (Averill 33:12.)
	Brunswick				See Miners' group, herein.
37	Buena Vista	Sec. 5, T 31 N, R 5 W, MDB&M	H. G. Graves, Redding...	N-trending vein in greenstone dips 30° for 30-ft. depth, then 45°. Faulting at 50-ft. level. Vein above faulting is 5 ft. wide, contains pyrite, and a little chalcopyrite, partly oxidized; it is 2 ft. wide below (but 2 separate veins may be present here). Vein said to average $30/ton in gold. Another vein 1,000 ft. E said to assay $5–6. Some scheelite present in workings; grade does not vary vertically.	About 3 mi. W of Redding. Located 1927, active 1930s. Inclined shaft 187 ft. deep with 100 ft. of drifting at bottom; 224 ft. of drifts at 30-ft. level, 40 ft. at 90-ft. level. Small flotation plant. Patented 1961. Idle. (Averill 33:15; 39:134.)
	Bullard and Vandever				See Menzel.
	Bully Hill-Rising Star	Sec. 15, 16, 21, 22, 28, T 34 N, R 3 W, MDB&M	Glidden Company, Union Commerce Building, Cleveland, Ohio	Yielded 38,224 oz. gold from complex sulfide ore, 1900–50.	(Albers and Robertson 61:90.) For extended list of references, see tabulated list under copper; for additional description, see herein under copper.
	Bulwer and Virginia	Sec. 18, T 33 N, R 7 W, MDB&M	Undetermined	3 parallel veins between slate and granite porphyry strike N, dip 65° E. Oreshoot 2 ft. wide, 200 ft. long.	3 mi. NW of French Gulch. 700-ft. adit on vein. Small production. Idle. (Brown 16:780–781.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Bunker Hill	Sec. 29, T 32 N, R 5 W, MDB&M	Mrs. A. M. Whaley, 130 22nd Ave., San Francisco	Vein 5 ft. wide in granite porphyry strikes N, dips 40° E, and contains massive sulfide ore in which covellite replaces bornite. Ore said to assay $7/ton.	About 3 mi. NW of Redding. Several acres patented land. Active prior to 1907 and in 1940s. 460-ft. adit, 200 ft. of drifts. Idle. (Brown 16:781; Hollister 49.)
	California and Oregon	T 33 N, R 5 W, MDB&M.	Undetermined	Parallel veins 3 and 5 ft. wide carry copper sulfides.	3 mi. SW of Kennett. 40-ft. shaft, shallow surface cuts. Idle. (Crawford 96:351.)
	California Progressive				See Clipper and Snyder group.
38	Calumet Consolidated	Sec. 10, T 32 N, R 5 W, MDB&M	Henry D. McIntosh, 3416 34th Street, Sacramento	Vein in greenstone strikes W, dips 15° N. Payshoot 20 in. wide, 200 ft. long. Ore free milling near surface, base at depth.	About 5 mi. N of Redding, in Old Diggings district. Adit 1,000 ft. long, several hundred ft. drifts, raises, stopes. Ore was worked in 20-stamp mill. Active 1870s to early 1900s; producer. Idle. (Irelan 88:563; McGregor 90:631–632; Fairbanks 93:43; Hodson 93:395; Brown 16:781; Averill 33:17; 39:146–147.)
	Caribou Gold Mining and Power Company				See Mad Ox.
	Carnegie				See Clipper and Snyder group.
	Cates group	Sec. 4, T 35 N, R 6 W, MDB&M	Undetermined	Vein 25 ft. wide in greenstone strikes N, dips 45° W. N of main adit, vein pinches to gouge seam. Porphyritic andesitic dike at footwall of vein. Smaller 15-in. vein 32 ft. to E. Gently(?)-dipping contact with black slate exposed in older adit.	About 7 mi. W of Delta. 355-ft. crosscut adit cuts wide vein at 181 ft., 80 ft. below surface. Drifts 75 ft. N, 28 ft. S on hanging wall, and 8 ft. N, 32 ft. S on footwall. Old 154-ft. adit 110 ft. lower thought to be 450 ft. from vein. Idle. (Averill 39:134–135.)
	Celestine				See Double Header.
	Centennial	Sec. 7, T 33 N, R 7 W, MDB&M	W. K. Jansen, Box D, Lincoln, and E. M. Clark, Box 11, French Gulch	Vein strikes N 60° E in slate, above contact with greenstone. Oxidized ore in open cut, primary ore in adits.	4 mi. NW of French Gulch. Discovered 1876. Open cut 6 ft. wide, 140 ft. long; several adits. (Crawford 94:253; Albers, 65:22.)
39	Central	Sec. 3, 4, T 32 N, R 5 W, & Sec. 33, 34, T 33 N, R 5 W, MDB&M	J. K. Johns et al., P.O. Box 174, Summit City		(Irelan 88:565; McGregor 90:631; Crawford 94:246; 96:351; Diller 04:171; Brown 16:782; Tucker 22:494; Logan 26:170–171; Averill 33:17–18; 39:146–147; herein.)
	Clara	Sec. 17, T 32 N, R 5 W, MDB&M	Edward J. Ahern, Alamo	3 parallel veins in granite porphyry. Payshoot 20 in. wide, 160 ft. long, carries free gold.	Near Keswick. 700-ft. adit. Small producer. Idle. (Brown 16:782.)
40	Cleveland(Gladiator,Hiatt)	Sec. 15, T 32 N, R 5 W, MDB&M	Gladiator Gold Mining Company, 21287 Birch Ave., Hayward	Steeply-dipping vein of stringer quartz 1–3 ft. wide in greenstone, strikes NW. 2 oreshoots 100 ft. long.	3 mi. NW of Redding. 60 acres patented. Some rich ore shipped prior to 1914. 200-ft. shaft with 250 ft. of drifts and stopes at 100-ft. level, 30 ft. of drifts at bottom. Idle. (Brown 16:782; Averill 33:27–28.)
	Climax	Sec. 16, 21, T 31 N, R 6 W, MDB&M	Grace J. Marton; address undetermined	In 1920s, ore shipment of 4,210 lbs. assayed 0.08 oz./ton in gold.	2 mi. N of Igo. Idle. For geology and additional description, see in section on silver. (Brown 16:782; Logan 26:205–206.)
41	Clipper and Snyder group (California Progressive, Carnegie, Los Andes, Snyder)	Sec. 31, T 34 N, R 5 W, & Sec. 36, T 34 N, R 6 W, MDB&M	California Progressive Mining Company, c/o Mark Nightingale, Summit City	Snyder vein 2–6 ft. wide, dips 45° between porphyry and slate. Said to average $5–$9 in free gold and sulfides; one lot of 415 tons reportedly yielded $4,183 free gold, $12,300 in sulfides. Maude vein 1½ ft. wide, averaged $20/ton. Huston vein 2–6 ft. wide, averaged $9/ton in adit. Clipper vein 5–7 ft. wide, strikes NW, dips 45°; assayed $8–$30/ton in adit, with approximately equal values of free and sulfide gold. Peripherally-altered plug of coarse Balaklala Rhyolite nearby.	4 mi. NW of Shasta Dam. 230-ft. shaft on Snyder vein with 125 ft. of drifts at 50 ft., 310 ft. at 150 ft., and 360 ft. at 200 ft. 525-ft. adit on Huston vein. 326-ft. adit on Clipper vein, with 44-ft. winze at 140 ft. Ore worked in 10-stamp mill during 1890s and 1900s. Idle. (McGregor 90:640–641; Hodson 93:399; Crawford 94:246; 96:351; Brown 16:781; Averill 33:19–20; Kinkel et al. 56:67.)
	Colorado	Sec. 8, 17, T 33 N, R 7 W, MDB&M	Robert Emmet McDonald, 760 Edgewood Road, San Mateo	Vein 10 in. wide strikes NE, dips 40° N. Free-milling ore in shoot 160 ft. long.	About 3 mi. NW of French Gulch. 400-ft. adit on vein. Idle. (Brown 16:782.)
	Colorado	T 31 N, R 6 W, MDB&M	Undetermined	3-ft. vein strikes E, dips 55° S. Ore carries large masses ferruginous quartz and sulfides.	2 mi. SW of Shasta. Idle. (Crawford 94:246.)
	Colorado (D&B, Remonia)	T 31 N, R 5 W, MDB&M.	Undetermined	Vein 4½ ft. wide strikes NE, dips 60° W, between granitic walls.	4 mi. SW of Redding. 4 shafts 10–45 ft. deep. Idle. (Crawford 94:256; 96:352.)
42	Combination	Sec. 17, T 33 N, R 7 W, MDB&M	Irven and Billie Van Sickle et al., French Gulch	Stringers of calcite and quartz in NE-trending fault in soft slate of Bragdon Formation. Quartz with pyrite assays $7–$10/ton.	In Scorpion Gulch, 3 mi. NW of French Gulch. 200-ft. adit follows fault; some drifting. Selected material milled at Washington mill. 4 men employed by Dorothy B. Mines, Inc., lessees, in 1959.
	Compton	Sec. 20, T 32 N, R 5 W, MDB&M	Undetermined	Vein in granite porphyry; short pay shoot.	About 1 mi. S of Keswick. Short adit and drift. Idle. (Brown 16:782.)
	Conner				See El Dorado.
	Consolidated Kascinaska				See Original Quartz Hill.

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Consolidated Kosciusko				See Original Quartz Hill.
	Continental	Sec. 7, 18, T 31 N, R 6 W, MDB&M	V. V. Apperson, Willows	Quartz vein 18 in. to 3 ft. wide in granodiorite strikes N 45° E, carries argentiferous galena, pyrite, tetrahedrite, sphalerite, native silver, and gold.	About 4 mi. NW of Igo. Developed by adit driven N 50° W and 200-ft. drift driven NE. 6-stamp mill in 1880s. Long idle. (Tucker 26:206.)
	Copley (Diamond King)	Sec. 32, T 33 N, R 5 W, MDB&M	Undetermined	4-ft. vein strikes NE; contains free gold in oxidized zone, grading down to sulfide ore.	Near Matheson. 310-ft. adit, 60-ft. drift, stope. Idle. (Crawford 96:352; Brown 16:783.)
	Copper Snake	Sec. 9, 16, T 35 N, R 6 W, MDB&M	Undetermined	Faulted quartz vein at contact between greenstone and albite granite. Irregular masses chalcopyrite and minor pyrite in gray quartz said to contain 0.6 oz. gold, 4 oz. silver, and 15% copper. Free gold near surface, associated with manganese oxide stains.	On Stacey Creek, about 7 mi. SW of Vollmers. 3 short adits. Prospect. (Ferguson 14:72–73.)
	Corrinne	Sec. 32, T 32 N, R 5 W, MDB&M	Undetermined	2 parallel, vertical veins strike NE. Payshoot 15 in. wide, 200 ft. long, carries free gold and sulfide ore.	About 3 mi. W of Redding. 4 adits 60–430 ft. long; "old" 110-ft. shaft with 600 ft. of drifts and 160-ft. stope. Gold was recovered in 5-stamp mill. May refer to Corinne vein of Salt Creek group; see under Bonanza. Idle. (Brown 16:783.)
	Cortez	Sec. 10, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Co., 1206 Pacific Mutual Bldg., Los Angeles	2 parallel veins 40 ft. apart	At Ingot. 3 short adits. Idle. One of Afterthought claims, which see in copper section, herein. (Crawford 94:70; 96:352; Brown 16:783.)
	Crown Deep				See Gold Leaf.
	Crown Point	Sec. 1, 2, T 35 N, R 6 W, MDB&M	Regis E. Halter, Redding	Vein 2 ft. wide strikes E, dips S.	6 mi. W of Delta. 2 adits on vein, 70 and 300 ft. long; 140-ft. raise to surface. Idle. (Crawford 96:353.)
	Crystal Creek				See Gold Dollar.
	D & B				See Colorado.
	Daisy	T 34 N, R 7 W, MDB&M.	Undetermined	A few quartz stringers.	5 mi. N of French Gulch. 850-ft. adit; air shaft at 340 ft. Idle. (Crawford 96:353.)
	Dayton				See Diamond.
	Davidson	T 33 N, R 2 W, MDB&M.	Undetermined	Shipped ore yielded 11.4% copper, 6.8% lead.	In Ingot area. Small shipment high-grade gold-silver ore in 1913. (Goodwin 57:688.)
	Deakin and Taylor				See Old Spanish, herein.
43	Delta Consolidated	Sec. 1, T 35 N, R 6 W; Sec. 6, T 35 N, R 5 W, & Sec. 31, T 36 N, R 5 W, MDB&M	Undetermined	10 vertical veins 1–2 ft. wide strike N 70° E in greenstone, contain chalcopyrite, pyrite, galena, sphalerite, and arsenopyrite in dark quartz. Payshoot 18 in. wide, 800 ft. long, assays $8–$10/ton in sulfide and free milling gold. Production to 1912 was $32,000, not including early arrastre milling.	About 3 mi. SW of Delta. 30 claims. Several adits on veins 20–1,600 ft. long, raises 100–200 ft. high, and 200-ft. stope. Ore treated in 10-stamp mill. Long idle. (Crawford 96:353; Ferguson 14:71–72; Brown 16:784.)
44	Desmond (Aurora)	Sec. 9, T 32 N, R 6 W, MDB&M	John I. Desmond, et al., Redding	Vein strikes N 50° E, dips 50° S. Reportedly yielded 150 tons of $20 ore in mid-1930s.	About 1½ mi. N of Whiskeytown. Shaft on vein 135 ft. deep; adit connects shaft and 40-ft. winze with drift at bottom. Idle. (Averill 39:135.)
	Diamond (Black Prince)	Sec. 7, 18, T 31 N, R 6 W, MDB&M	R. S. Ballou, Igo	4 veins with granitic footwall and greenstone hanging wall. Payshoot 2 ft. wide, 100 ft. long, contains sulfide ore below oxidized zone. Shipping ore returned $50/ton in gold and silver.	About 4 mi. NW of Igo. 5 patented claims. 400-ft. adit, short drifts, stope. Idle. (Crawford 94:377–378; 96:350; Brown 16:784.)
	Diamond (Dayton)	T 31 N, R 7 W, MDB&M.	Undetermined	Veins 6 in. to 4 ft. wide.	6 mi. NW of Igo. 300-ft. adit. Idle. (Crawford 96:355.)
	Diamond King				See Copley.
	Dolcoath	Sec. 29, T 32 N, R 5 W, MDB&M	Undetermined	Vein 2½ ft. wide strikes E.	2 mi. E of Shasta. Shaft 24 ft. deep with drift E. Idle. (Crawford 94:247; 96:355.)
	Don Carlos	T 31 N, R 5 W, MDB&M.	Undetermined	High assays from vein.	About 6 mi. SW of Redding. 102-ft. adit, 44-ft. shaft. Idle. (Fairbanks 92:398.)
	Double Header (Celestine)	Sec. 33, T 33 N, R 7 W, MDB&M	Helen Eifort, French Gulch.	Low-grade vein up to 5 ft. wide in greenstone strikes N, dips 45° E. In surface workings, slate forms one wall and good values were recovered.	About 2 mi. NW of Tower House. Small producer in 1888. 400-ft. adit on vein 150 ft. below surface workings was extended 120 ft. in 1931. Idle. (Irelan 88:567–568; Tucker 22:138, 354, 405; 23:11; Averill 33:21.)
	Dowling Mining and Investment Company				See Walker, herein.
	Dreadnaught (Drednot)	Sec. 10, 11, T 32 N, R 6 W, MDB&M	Undetermined	Vein 2½ ft. wide strikes E.	3 mi. NW of Shasta. 14 claims, 40-ft. adit and 20-ft. shaft on vein. Ore was worked in arrastra. Long idle. (Crawford 94:247; 96:355.)
	Drednot				See Dreadnaught.

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Eastern Star	T 30 N, R 7 W, MDB&M.	Undetermined	Vein 4 ft. wide strikes NE.	14 mi. SW of Redding. Shafts 96 and 30 ft. deep, 250-ft. adit. Considerable flow of water encountered. Idle. (Crawford 94:247; 96:353.)
	East View (Winnie)	Sec. 6, T 32 N, R 6 W, MDB&M	Jack Floyd, et al., Redding.	Quartz fissure vein 1 in. to 2 ft. wide in greenstone intruded by quartz diorite dikes. Upper 50 ft. said to contain good ore.	3 mi. NW of Whiskeytown. Adit 500 ft. long with 100 ft. on vein. 40-ft. crosscut adit. Idle. (Averill 33:21–22.)
	Edna B	Sec. 6, T 31 N, R 5 W, MDB&M	Undetermined	Vein 3 ft. wide in quartz porphyry strikes NE, dips 45° E.	About 1½ mi. SE of Shasta. 500-ft. adit on vein. Small production. Idle. (Crawford 94:247; 96:355; Brown 16:785.)
45	Eiller (Gold Hill)	Sec. 11, T 32 N, R 6 W, MDB&M	H. M. Hose and Melvin Zeiss, Redding	Vertical quartz vein 3–11 ft. wide strikes E in quartz diorite. Rhyolitic dike exposed 200 ft. SW of workings. 11-ft. vein assayed $1/ton; 3-ft. vein panned well at surface, gave "good assays" in drift.	On SE slope of South Fork Mountain, 2 mi. NE of Whiskeytown. Active 1880–89, 1928–29, 1930s. Earliest workings include 400-ft. adit and another, 125 ft. lower, probably 1,900 ft. long. 700 ft. of lower tunnel cleaned and retimbered in 1920s, exposing 11-ft. quartz vein. Surface cut exposed 3-ft. vein. 75 ft. below this, adit driven 42 ft. SW, then drift 140 ft. W to same (?) vein. Idle. (Averill 33:22; 39:135.)
46	El Dorado (Conner, Eureka)	Sec. 3, T 32 N, R 7 W, MDB&M	F. C. Bickford, Whitmore	Broken lenses of quartz 2 ft. wide along fault-contact between greenstone and slate that strikes N 20° W, dips 50°–70° E. Gold occurs in pockets in quartz, gouge, and in clusters of small quartz veinlets in greenstone. Gold fineness said to be low. Production estimated at $25,000 by mid-1912.	½ mi. SW of Tower House, near French Gulch. 450-ft. adit on lode; 50-ft. winze at 250 ft. from portal has a drift 26 ft. to N; at 340 ft. from portal, a raise and stope in ore. Idle. (Crawford 94:247; 96:355–356; Ferguson 14:56–57; Brown 16:785; Tucker 22:405–406; 23:11; 26:171; Albers, 65:33.)
	Elizabeth	Sec. 34, 35, T 32 N, R 6 W, MDB&M	Edna Behrens Eaton, et al., Redding		About 2 mi. SW of Shasta. No published report.
	Ellis	Sec. 6, T 33 N, R 5 W, MDB&M	L. C. Monahan, Berkeley, and M. E. Dittmar, c/o W. W. Henry, 30 San Pablo Ave., Richmond	Vein 18–20 in. wide assayed $8 in gold and silver, 2½% copper.	4 mi. NW of Shasta Dam. Patented claim. Vein cut by long adit driven NE from Bonanza claim of Uncle Sam group, more than 1,300 ft. below surface. Idle. (Averill 33:22.)
	Emigrant				See Truscott.
	Empire	Sec. 9, T 30 N, R 7 W, MDB&M	Undetermined	2 parallel veins in slate. Free-milling payshoot 1 ft. wide, 80 ft. long.	About 1 mi. W of Ono. 500-ft. adit. Very small production. Long idle. (Crawford 96:356; Brown 16:785.)
	Empire	Sec. 18, T 33 N, R 7 W, MDB&M	Mary and Margaret Franck, French Gulch	Vein between granite porphyry and slate strikes E, dips 15° N. Oreshoot 6 ft. wide, 100 ft. long.	4 mi. NW of French Gulch. 4 adits, 115 to 500 ft. long; 300 ft. drifts and stope 100 ft. long. Small producer. Idle. (Crawford 96:356; Brown 16:785.)
	Enright				See Old Spanish, herein.
	Esperanza	Sec. 29, T 29 N, R 10 W, MDB&M	Undetermined	4 veins exposed on surface	About 8 mi. W of Platina. 214-ft. shaft, 3 crosscuts on Lucky George claim. Long idle. (Brown 16:785.)
	Ethel	T 30 N, R 7 W, MDB&M.	Undetermined	Vein 4 ft. wide strikes N.	14 mi. SW of Redding. Adit driven 100 ft. to vein; 20-ft. drift and 16-ft. winze on vein. Long idle. (Crawford 94:248.)
	Eureka				See El Dorado.
47	Eureka Tellurium (Telluride Consolidated)	Sec. 29, T 32 N, R 5 W, MDB&M	John J. Bartosh, et al., 1439 Yuba St., Redding	Vein 3 ft. wide in slate strikes N 25° E, dips 60° E. 130-ft. oreshoot contains free gold near surface, sulfides at depth. Some tellurides.	About 3 mi. NW of Redding. Discovered in early 1850s. Small production around 1901. Several adits, one 520 ft. long. Idle. (Irelan 88:571; Fairbanks 93:43; Crawford 94:248; 96:356–357; Brown 16:786.)
	Evening Star (Bright Star, Iron Mask)	Sec. 30, 31, T 33 N, R 6 W, MDB&M	J. H. Scott, 11 Corte Encanto, San Rafael	18-in. vein strikes N, dips steeply E in metarhyolite and locally at metarhyolite-slate contact. Large mass hornblende dacite porphyry nearby. A second vein 30 ft. from and parallel to first is exposed on main level.	Just N of Mad Mule Mountain, about 4 mi. NW of Whiskeytown. 190-ft. crosscut adit to vein; 600 ft. of drifting on this level, with winze that passed out of ore at 30 ft. At 125-ft. level, drifts go 130 ft. N, 100 ft. S; raise 60 ft. N of winze struck ore. Stopes above main level. Idle. (Crawford 94:250; 96:359; Ferguson 14:55; Brown 16:780; Averill 33:23; Kinkel et al. 56:39, 51.)
	Evening Star	Sec. 17, T 33 N, R 7 W, MDB&M	Estate of E. H. Blagrave, French Gulch		About 3 mi. NW of French Gulch, between Milkmaid and Washington mines. Assessment work only. Idle. (Laizure 21:520; Averill 33:22.)
48	Evening Star	Sec. 3, 4, T 32 N, R 5 W, MDB&M	Joseph K. John, Box 174, Summit City, and Oscar Ouesenberry, Redding	3 parallel veins strike NW, dip S. Payshoot 14 in. wide, 230 ft. long.	S of Reid mine in Old Diggings district, about 5 mi. N of Redding. Active early 1900s. Adit 1,100 ft. long, and 1,000 ft. of drifts. Long idle. (Diller 04:171; Brown 16:786; Averill 33:22–23.)
	Florence	Sec. 18, T 30 N, R 7 W, MDB&M	Undetermined	Vein 10 ft. wide in slate strikes N 30° W, dips 40° E. Low-grade auriferous sulfides carry copper, lead, zinc.	About 4 mi. SW of Ono. Slightly developed. Long idle. (Brown 16:786.)
	Florida				See Boswell group.
	Forbes				See National.
	Franklin	Sec. 10, T 33 N, R 2 W, MDB&M	Undetermined	Short oreshoot with "some" high-grade ore.	1 mi. SW of Ingot. Short adits. Idle. (Brown 16:786.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Franklin	Sec. 29, T 32 N, R 5 W, MDB&M	Undetermined		1½ mi. S of Keswick. Undeveloped. Idle. (Averill 39:180.)
49	Franklin and Milkmaid (Milkmaid and Franklin, Western)	Sec. 8, 9, 16, 17, T 33 N, R 7 W, MDB&M	Mountain Copper Company of California, 100 Mococo Road, Martinez		(Ferguson 14:61–64; Brown 16:793–794; Tucker 22:43, 406–407; 23:11; Logan 26:175–176; Averill 33:37; 39:142–143; Albers 65:26–27; herein.)
	French Gulch Mining Company				See Gladstone, herein.
	G. A. R.				See McCarthy, Saeltzer and Smith.
	Gage and Martin	T 31 N, R 6 W, MDB&M.	Undetermined	Vein 16-in. wide strikes E, dips N.	1½ mi. S of Shasta. 140-ft. adit. Idle. (Crawford 96: 357.)
50	Gambrinus (Shasta Monarch Mining Company)	Sec. 16, T 32 N, R 6 W, MDB&M	Undetermined	4 veins in Balaklala Rhyolite near contact with greenstone have strikes ranging from W to N 45° W, dips 45° N to vertical. 3 NE veins are in 60-ft. zone of silicified metarhyolite. Irregular lenses of quartz in shear zones contain free gold and pyrite in oxidized zone, auriferous pyrite at depth. Silicified zone said to assay $8/ton. Production to mid-1912 was $127,000 (Ferguson, 1914).	On E bank Whiskey Creek opposite Whiskeytown site. Located about 1870; active intermittently for next 50 years. Several adits, one 410 ft. long; stopes, drifts, and 110-ft. crosscut. Ore worked in 10-stamp mill. Idle. (Ferguson 14:50–51; Brown 16:786–787; Averill 33:26; Albers 65:33.)
	Ganim	Sec. 5, 8, T 32 N, R 6 W, MDB&M	Ganim Gold Mining Company, Wm. G. Thompson, Secretary, Redding		See tabulated list under talc for references, and under talc herein for description.
	Garfield (Acme, Lone Cedar)	Sec. 34, T 33 N, R 5 W, MDB&M	Oscar Ouesenberry, P.O. Box 752, Redding	Quartz vein, 14–18 in. wide shows iron oxide and some chalcopyrite. Oreshoot 2 ft. wide, 90 ft. long. Grab sample from 5-ton dump said by Ouesenberry to assay $10/ton in gold. About 90% of gold is sulfides, remainder free.	About 6 mi. N of Redding. 570-ft. adit, 230-ft. drift. Small producer. Idle. (Hodson 93:397; Brown 16: 787; Averill 33:34.)
	Gem	Sec. 19, T 32 N, R 5 W, MDB&M	Anna Baker, 1917 Ninth Avenue, Redding	4-ft. vein contains series of rich oreshoots.	4 mi. NW of Redding. Inclined shaft 125 ft. deep with E and W levels at bottom. Ore was treated in 10-stamp mill. Idle. (McGregor 90:632.)
	Gladiator				See Cleveland.
51	Gladstone (French Gulch Mining Company, Hazel Gold Mining Company)	Sec. 7, 8, 17, 18, T 33 N, R 6 W, MDB&M	Hazel Gold Mining Co., 3126 Ebano Drive, Walnut Creek		(Irelan 88:568–569; McGregor 90:637; Hodson 93: 45; Crawford 94:248–249; 96:357; Ferguson 14: 57–60; Brown 16:787–788; Tucker 22:43, 96, 256; 23:11; Logan 26:172–173; Averill 33:28; 39:135; Kinkel et al. 56:57; Albers 65:22–24; herein.)
	Gladys	Sec. 34, T 32 N, R 6 W, MDB&M	Undetermined	2 parallel veins 4–6 ft. wide strike N 55° E, dip 85° N.	About 3 mi. SE of Whiskeytown. 300-ft. adit and 130-ft. shaft with drifts 75 ft. N and 50 ft. S. Long idle. (Laizure 21:521.)
	Gold Bar	Sec. 7, T 33 N, R 6 W, MDB&M	Undetermined	Vein 3 ft. wide strikes NE, dips N.	About 4 mi. NE of French Gulch. Several shafts 8–10 ft. deep. Long idle. (Crawford 96:358.)
	Gold Bar No. 1–4	Sec. 22, 26, T 33 N, R 5 W, MDB&M	Elta V. Proebstel et al., Box 102, Shasta	Quartz vein 4 ft. wide in greenstone strikes N 30° W, dips 55° W, can be traced for 6,000 ft. Oreshoot 4 ft. wide, 80 ft. long in upper adit said to carry $10–$15/ton in gold. Ore milled in 1891 reportedly yielded $50/ton.	Near Summit City. Active in old days until 1891; active again 1923–25. 3 adits on vein, with stopes between. Upper adit 100 ft. long, 30 ft. above middle adit. Idle. (Tucker 23:93; Logan 26:173.)
	Gold Chariot				See Golden Chariot.
	Gold Dollar (Crystal Creek)	Sec. 8, T 32 N, R 7 W, MDB&M	Henry Carter et al., French Gulch	Limonite-stained quartz vein 3 ft. wide strikes N 60° W, dips 50° NE.	About 3 mi. SW of Tower House. 40-ft. adit, several shallow shafts and trenches. No production recorded.
	Gold Hill				See Eiller.
	Gold Hill				See Midas.
52	Gold Leaf (Crown Deep, Miller)	Sec. 5, T 31 N, R 5 W, MDB&M	H. G. Graves et al., Redding	A series of parallel veins 2–6 ft. wide strike NE, dip E. Gold is associated with pyrite.	About 2½ mi. SE of Shasta. Vertical shaft 400 ft. deep with levels at 100-ft. intervals; stoped to surface above 300-ft. level. Idle. (Crawford 96:358; Diller 04:171; Laizure 21:521–522; Tucker 22: 296, 298, 354, 406, 495; 23:11; Averill 33:28.)
	Gold Nugget	Sec. 30, T 32 N, R 5 W, MDB&M	S. M. Harvey, Shasta	Quartz vein in greenstone contains free gold in pockets.	About ½ mi. E of Shasta. 30-ft. shaft and shallow cuts. Small production. Idle.
	Golden Blanket				See Bjork.
	Golden Chariot (Gold Chariot)	Sec. 6, 7, T 31 N, R 5 W, & Sec. 1, T 31 N, R 6 W, MDB&M	Jack A. and Dorris W. Allen, Red Bluff	Vertical quartz vein 3–4 ft. wide in quartz diorite intersects another vein.	2 mi. S of Shasta. 165-ft. caved adit partly cleaned out in 1933. Idle. (Averill 39:137.)
	Golden Crown	Sec. 19, T 31 N, R 6 W, MDB&M	Undetermined	Vein 1 ft. wide in granitic rock. Free gold in short oreshoot.	About 3 mi. NW of Igo. Slightly developed. Small producer. Idle. (Brown 16:788.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Golden Queen	T 32 N, R 5 W, MDB&M.	Undetermined		5 mi. NW of Redding. Located 1922. Prospect. Idle. (Tucker 23:354.)
	Gossan group	Sec. 31(?) T 36 N, R 5 W, MDB&M	Undetermined	Outcrop 80 ft. wide carries copper, iron, gold, and silver.	3 mi. W of Delta. Idle. (Crawford 96:358.)
	Grandview				See Black Diamond.
	Gray Eagle	Sec. 10, T 29 N, R 10 W, MDB&M	Adele Moore, 608 Rincon Road, Santa Rosa	Vein 1 ft. wide with slate footwall, diabase hanging wall. Short oreshoot.	At Knob. Idle. (Brown 16:789.)
	Gray Eagle				See Sunny Hill.
	Great Falls and Hope				See Ballou.
	Great Western (Stony Gulch)	SW¼ Sec. 14, T 31 N, R 6 W, MDB&M	Norman Lane, Knob Rt., Redding	Vertical vein a few inches to 3 ft. wide in quartz diorite strikes NE, is associated with a mafic dike. Parallel vein 15 ft. to NW is a few inches wide, contains massive pyrite streaks locally. 10 tons ore from point 300 ft. SW of adit portals yielded $11/ton in free gold. Albers reports small production of $20–$28 ore.	In Muletown district about 2½ mi. NE of Igo. 4 claims. Vein exposed in gulch from which 350-ft. adit driven NE on vein with 2 crosscuts NW to parallel vein; 50 ft. of drifting on latter. 150-ft. adit driven on vein SW from gulch. (Averill 33:29–30; 39:149; Albers 65:31.)
53	Green	Sec. 7, T 30 N, R 7 W, MDB&M	Larry Henke, Mr. Petersen, et al., Ono	Narrow shear zone in massive greenstone strikes N 48° E, dips 85° N, contains discontinuous stringers of quartz.	5 mi. W of Ono. 6 claims, including site of older Woodfill claim, which see. Old workings on property; present owners located 1958. Shallow shaft. No recorded production.
	Green				See Tom Green.
	Greenhorn				See Greenhorn mine in copper section, herein.
	Gypsy Gold & Silver	T 31 N, R 6 W, MDB&M.	Undetermined	Vein 4 ft. wide strikes E between granite and diorite.	2 mi. SW of Shasta. 50-ft. shaft. Idle. (Crawford 94:249; 96:358.)
	Halcyon and Washington	Sec. 17, T 33 N, R 7 W, MDB&M	J. H. Scott, 11 Corte Encanto, San Rafael	Free gold associated with numerous thin quartz stringers in soft, decomposed diorite porphyry near contact with Bragdon Fm. slate. Contact strikes NE, dips 80° NW. Ore in 1932 said to have yielded $8–$12/ton.	3 mi. NW of French Gulch. 400-ft. adit, 130-ft. shaft, 500 ft. of drifts by 1914. Several hundred feet shallow workings run in early 1930s. Amended location made 1941. Leased beginning 1962. In February 1964, U.S. Government granted an O.M.E. matching-funds loan of $20,980. (Brown 16:789; Averill 33:30–31.)
	Hall Brothers (Scharrell)	Sec. 2, 11, T 31 N, R 6 W, MDB&M	Western Star Lodge No. 2, F.&A.M., c/o Charles E. Hall, Redding	Quartz vein 4 in. to 2 ft. wide carries free gold, pyrite, and chalcopyrite. Pockets carrying $300 and $500 in gold found during 1930s.	On N slope Mule Mountain. Open cuts, 39-ft. shaft, and 2 older adits 160ft. long and 100 ft. with 150 ft. of drifts. Idle. (Averill 39:138–139.)
	Hall's	Sec. 6, T 31 N, R 8 W, MDB&M	Undetermined	Vein 14 in. wide strikes NW, contains iron oxides and chalcopyrite.	10 mi. NW of Ono. Idle. (Crawford 96:358–359.)
	Happy Jack group				See in copper section.
	Harrison Gulch group				See Midas.
	Hartman	T 33 N, R 6 W, MDB&M.	Undetermined	Vein 2 ft. wide.	3½ mi. N of Whiskeytown. 2 adits 50 ft. long, 45-ft. shaft. Idle. (Crawford 94:250.)
	Hazel Gold Mining Company				See Gladstone, herein.
	Hiatt				See Cleveland.
	Hidden Treasure	T 32 N, R 5 W, MDB&M.	Undetermined	Vein 10 in. to 7 ft. wide strikes E, dips N. Ore contains some copper sulfides.	8 mi. NE of Shasta. 2 adits, some stoping above upper adit. Ore treated by amalgamation in 10-stamp mill. Long idle. (Crawford 94:250; 96:359.)
54	Highland	Sec. 9, 10, T 33 N, R 7 W, MDB&M	Undetermined	Faulted vein in Bragdon slate strikes W, dips 40° S. Oreshoot 7 ft. wide in faulted segment yielded $15/ton in free-milling gold in 1932. Dumps pan well. Production reportedly $400,000 prior to 1855, but only data available show $4,322 in 1869 and $9,650 in 1871.	About 2½ mi. NW of French Gulch. 100-ft. adit with 22-ft. winze on oreshoot. (Ferguson 14:69 Brown 16:789; Averill 39:139–140; Albers 65:24.)
55	Highland Lake (N.R.A.)	Sec. 12, T 37 N, R 6 W, MDB&M	Undetermined	Fragmented quartz vein in sheared serpentine and peridotite; wallrock contains visible free gold.	7 mi. NW of Gibson. 5 claims. Area first prospected 1889; some work in recent years. Surface cuts, 132-ft. inclined shaft with short crosscuts N and S at 70 ft. No recorded production. (Averill 39:140; O'Brien 48:359.)
56	Hoboe	Sec. 17, T 33 N, R 7 W, MDB&M	Howard Thatcher and C. A. Westlake, Redding	Nearly-vertical 2-ft. quartz vein between slickensided black slate and massive biotite dacite porphyry; strong walls in near-surface workings. Mineralization includes pyrite crystals and pyrite smears along rock fractures. 7 tons sorted ore yielded 24 oz. gold, 6 oz. silver in 1945.	2½ mi. NW of French Gulch. Active intermittently since 1920s. First worked by adit above road level, and ore mined by underhand stoping. New adit started in 1957 100 ft. below, but more than 150 ft. of drifting by 1963 failed to locate vein. (Averill 33:31.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Holly	Sec. 15, T 32 N, R 5 W, MDB&M	John Pavlicek, Quartz Hill Road, Redding	Quartz vein in greenstone carries free gold.	2½ mi. NW of Redding. 30-ft. shaft.
	Holman	T 33 N, R 6 W, MDB&M.	Undetermined	Vein 2 ft. wide strikes NW, dips NE, contains pyrite and chalcopyrite.	2 mi. SW of Copley. 75-ft. adit and incline 25 ft. deep. Idle. (Crawford 96:359.)
	Honey Bee				See Tom Green.
	Honeycomb and Shea	Sec. 7, T 33 N, R 7 W, MDB&M	W. K. Jansen, Box D, Lincoln, and E. M. Clark, Box 11, French Gulch	Honeycomb vein strikes N 50° E, dips 45° S, at or near contact between slate and greenstone. Shea oreshoot has shallow rake W.	Near junction French and Centennial Gulches, about 3½ mi. NW of French Gulch townsite. Active in 1880s. 3 adits (Honeycomb) with stopes, raises, and winzes E of Centennial Gulch; 260-ft. adit and large open cut on Shea vein to W. (Crawford 94: 253; Albers 65:24–25.)
	Hope	Sec. 8, T 32 N, R 7 W, MDB&M	Undetermined	Vein in slate with free gold in oreshoot 1 ft. wide, 100 ft. long.	About 3 mi. SW of Tower House. 480-ft. adit, 400 ft. of drifts, stope 80 ft. long, and inclined shaft 140 ft. deep. Rich surface ore worked in arrastre. Long idle. (Brown 16:790.)
	Hope So				See Milton, herein.
	Horstman (We Hope)	Sec. 9, T 31 N, R 5 W, MDB&M	Undetermined	Nearly-vertical, narrow quartz vein in greenstone strikes N 50° E, contains galena and pyrite. "Good" gold assays reported.	About 3 mi. SW of Redding. Shallow shafts along 100 ft. of the vein. Idle. (Averill 39:140.)
	Hull and Murray	T 32 N, R 6 W, MDB&M.	Undetermined	Vein strikes NE, contains pyrite and chalcopyrite.	4 mi. N of Shasta. 100-ft. adit on vein, and shaft 76 ft. deep. Idle. (Crawford 94:250.)
57	Hummingbird	Sec. 21, T 32 N, R 5 W, MDB&M	R. D. Bailey, P.O. Box 2160, Buckeye Route, Redding	Free gold and auriferous sulfides in 18-in. vein of quartz and calcite in brecciated, schistose greenstone. Recovery of $408 reported by Bailey in 1959.	About 3 mi. NW of Redding. Acquired by Walda and Joseph Giles in 1952, by Bailey in 1959. Shallow shaft in gulch bottom, short drift SE at 10 ft.; flooded annually. Also 50-ft. adit. Ore worked by small Ellis mill, later by arrastre.
	Inca	Sec. 1 or 2, T 35 N, R 6 W, MDB&M	Undetermined		On Dog Creek, 4 mi. W of Delta and just W of 122° 30′ Long. Shipped sorted ore in sacks, 1903. (Diller 04:172.)
	Independence group	Sec. 4, T 29 N, R 10 W, & Sec. 32, T 30 N, R 10 W, MDB&M	E. Milisich, Redding	A number of quartz veins up to 6 ft. wide. "Good values" in gold.	W of Midas mine at Knob. 200 tons ore milled. Idle. (Averill 33:31.)
	Index group	Sec. 6, T 32 N, R 6 W, MDB&M	Undetermined	Series of parallel veins 2 in. to 6 ft. wide strikes E.	About ½ mi. N of Oak Bottom on ridge N of Clear Creek. 12 claims. 2 adits 140 and 150 ft. long, and a number of shallow shafts and cuts. Idle. (Tucker 23:57; Logan 26:174–175.)
	Inez	Sec. 19, 20, T 32 N, R 5 W, MDB&M	Undetermined	Short ore shoot has free gold near surface, sulfide ore at depth.	4 mi. NW of Redding. Several open cuts; 300-ft. adit, drift 100 ft. long. Idle. (Brown 16:790.)
	Iron Mask				See Evening Star.
	Iron Mask				See Truscott.
	Iron Mountain (Old Mine, Number 8)	Sec. 34, 35, T 33 N, R 6 W, MDB&M	Mountain Copper Company of California, 100 Mococo Road, Martinez		Herein. For references see under copper; for additional description see in sections on copper, iron, and pyrite, herein.
	Isabel and Queen	Sec. 8, T 32 N, R 6 W, MDB&M	Undetermined	Shear zone 10 ft. wide in greenstone strikes N 60° W, dips steeply N. Small quartz stringers in zone contain free gold. Quartz on old dumps contains chalcopyrite. Pocket 200 ft. from open cuts yielded $40 in 1932.	About 1 mi. NW of Whiskeytown. 2 open cuts on shear zone; several hundred feet of old adits elsewhere on claim. Idle. (Averill 33:31–32.)
	Jackson				See Billy McCormick.
	Janice group	Sec. 11, 12, T 32 N, R 6 W, MDB&M	R. M. Falk, address unknown	Series of parallel veins 2–4 ft. wide strikes E, dips N in hornblende quartz diorite. Some specimen material contains free gold and chalcopyrite.	About 3½ mi. N of Shasta. 2 shafts, 40 and 50 ft. deep. Idle. (Tucker 22:598.)
58	Jealous	Sec. 6, 7, T 32 N, R 5 W, MDB&M	Schofield Mining Company, Inc., 3128 Perlita Avenue, Atwater	Several quartz veins 4 in. to 4 ft. wide; vuggy quartz contains free gold.	About 6 mi. NW of Redding. Short adits and drifts. Idle.
	Jensen group	Sec. 24, T 31 N, R 6 W, MDB&M	Alfred E. Jensen, Redding.	Small seams of gouge contain lenses of pyrite. $2,400 taken from shaft in 1931.	About 3 mi. NE of Igo. Prospect cuts and inclined shaft 125 ft. deep. Idle. (Averill 33:32.)
	Jerusalem	Sec. 9, T 31 N, R 8 W, MDB&M	Southern Pacific Land Company, San Francisco	Vein 30 ft. wide trends NW.	On W slope Bully Choop Mountain. 2 adits 40 ft. apart; upper adit is 300 ft. long to vein, with 65-ft. drift on vein; lower adit 83 ft. long on vein. Idle. (Crawford 96:360.)
	J.I.C.	Sec. 13, T 33 N, R 7 W, MDB&M	Undetermined	Vein 2 ft. wide in slate strikes N 22° E, dips 68° W. High-grade ore in pockets occurs in oreshoot that may rake steeply W.	About 2 mi. NE of French Gulch. 100-ft. adit, 300 ft. of drifts, and 220 ft. of inclined shafts. Idle. (Crawford 94:250–251; 96:360; Brown 16:790; Albers 65:25.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Jim Fisk	Sec. 15, T 31 N, R 6 W, MDB&M	Joseph John, c/o N. E. Lane, Knob Route, Redding	Quartz vein 1–2 ft. wide strikes N in quartz diorite, adjacent to a rhyolitic dike. Free gold occurs in ocher in quartz.	About 3 mi. N of Igo. Shallow shaft and intersecting adit. Ore was treated by amalgamation in experimental machine. (Crawford 94:251; 96:360; Averill 33:32.)
	Joe Davis	T 31 N, R 8 W, MDB&M.	Undetermined	Vein 14–18 in. wide in slate strikes NW, dips E.	On Jerusalem Creek 11 mi. NW of Ono. Shaft 35 ft. deep. Idle. (Crawford 96:360.)
	Jones				See Black Spider.
	Josephine and Providence				See Walker, herein.
	Jubilee	Sec. 23, T 31 N, R 6 W, MDB&M	Undetermined	5 veins with slate footwall and granite-porphyry hanging wall. Free gold in oreshoot 4 ft. wide, 100 ft. long.	About 2 mi. NE of Igo. Slightly developed. Idle (Brown 16:790.)
59	Jumbo	Sec. 23, T 31 N, R 6 W, MDB&M	Richard G. Woehr, Redding	Nearly-vertical quartz vein 6–10 in. wide in quartz diorite or between quartz diorite and small mass silicified greenstone; strike N 30° E. Ore consists of free gold and sulfides in ratio of 1:2 by value. Gold averages 800 fine. Yield about $4,000, according to owner. 400-ft. adit had been driven to intersect N-trending vein 8–16 in. wide that assayed $10/ton, but encountered only several small veins that yielded 2 wagonloads of $8 ore.	2 mi. NE of Igo. Active 1880s, 1900s. Relocated by Otto Miller 1939, purchased by Woehr 1957, patented 1961. 400-ft. adit driven E during 1880s yielded small amount ore in 1900s. More recent workings consist principally of narrow open cut 260 ft. long, 20 ft. deep.
	Jumbo	Sec. 1, T 31 N, R 5 W, MDB&M	James W. Taylor, Redding.	Bedrock of greenstone intruded by quartz diorite dikes and cut by a few quartz veins 12–18 in. wide.	5 mi. SW of Redding. Formerly worked as placer. Shallow shafts and cuts. Idle. (Laizure 21:522–523; Averill 33:32–33.)
60	Kanaka (Sunshine)	Sec. 15, T 32 N, R 6 W, MDB&M	Sunshine Gold Mining Company, E. Webber Ogden, V.P., First National Bank Bldg., Houston, Texas	Quartz veins 10 in. to 5 ft. wide at contact between greenstone and quartz diorite strike W, dip 60°. Pyrite and chalcopyrite in veins carry gold.	About 1 mi. E of Whiskeytown. Short adits, surface cuts, several hundred feet of drifts. Ore treated in 100-ton amalgamation and flotation plant. Small production. Idle. (Averill 33:33; O'Brien 48:359–360; 51:370–371.)
	Kit Carson	Sec. 3, 4, T 32 N, R 5 W, MDB&M	B. Wilbur, E. M. Shelton, Florence R. Erich, French Gulch	4 parallel veins 3 ft. wide with slate hanging wall and granite-porphyry footwall strike NE, dip 50° E. Low-grade oreshoot 200 ft. long.	About 1 mi. W of Buckeye. 700-ft. adit, 300 ft. of drifts. Idle. (Brown 16:790.)
	Koskiusco Mining Company				Also "Kosciusko"; see Original Quartz Hill.
	Laconia	Sec. 1, T 35 N, R 6 W, MDB&M	Undetermined	3 parallel veins strike W, dip 40° S between greenstone and quartz porphyry. Payshoot 3 ft. wide, 80 ft. long.	About 4 mi. SW of Delta. Developed by short adits. Idle. (Brown 16:790.)
61	Lady Slipper (Live Oak)	Sec. 11, T 32 N, R 6 W, MDB&M	H. A. Thompson, P.O. Box 119, Shasta	Vein 8–10 in. wide in albite granite strikes N 85° E, dips 78° N. 5 ft. of massive greenstone exposed in gully just W of shafts may be ore control. Quartz is glassy and brittle, contains gold free and associated with sparse nodules of massive pyrite and lesser amounts chalcopyrite and bornite.	3 mi. NE of Whiskeytown. 6-ft. shaft on property when patented 1896 by Willis Hyatt. Worked by Thompson 1953 to about 1960. 3 shafts, one 80 ft. deep.
	Last Chance	Sec. 23(?) T 31 N, R 6 W, MDB&M	Undetermined	Vein 2½ ft. wide between slate and porphyry strikes NE, dips 70° NW.	2½ mi. NE of Igo. Long idle. (Crawford 94:251.)
	Liberty	Sec. 31, T 33 N, R 5 W, & Sec. 36, T 33 N, R 6 W, MDB&M	Coronado Copper and Zinc Co., Pacific Mutual Building, Los Angeles	3 veins 2 ft. wide in quartz porphyry strike E, dip 65° N. Sulfide ore in payshoot 2 ft. wide, 220 ft. long.	1 mi. W of Matheson. Adit 1,850 ft. long, 250-ft. shaft and short drifts. Small producer years ago. Long idle. (Brown 16:790–791.)
	Little Judy group (Stella)	Sec. 19, T 32 N, R 5 W, MDB&M	Eldred M. Bicking, Shasta.	Gold occurs in pockets.	About 2 mi. NE of Shasta. A small production in 1956.
	Little Maud	Sec. 35, T 33 N, R 6 W, MDB&M	Undetermined	Vein 2 ft. wide strikes NE, dips 45° NW; contains 3% copper sulfides. Payshoot 55 ft. long, rakes W.	About 6 mi. from Shasta at E base of Iron Mountain. 3 adits 107, 109, and 295 ft. long. Ore treated in Huntington-type mill. Long idle. (Crawford 96: 361.)
	Little Nellie	Sec. 27, 35, T 33 N, R 6 W, MDB&M	Undetermined		3 mi. W of Matheson; SE of Iron Mountain mine. Free gold recovered from sulfide ore in 1880s. Gold production estimated at $160,000. Worked for copper in 1920s. See in copper section for references and geology.
	Live Oak				See Lady Slipper.
	Live Oak	T 32 N, R 5 W, MDB&M.	Undetermined	Vein 5–10 ft. wide in slate strikes NW, dips 60° NE.	About 4 mi. N of Redding. Prospect. Idle. (Crawford 96:361.)
	Lizzie Longley	Sec. 5 or 6, T 31 N, R 5 W, MDB&M	Undetermined	Series of rich payshoots in vein 4 ft. wide that can be traced on surface for several thousand feet.	In Lower Springs District, 4 mi. W of Redding. Two-compartment inclined shaft 125 ft. deep dips 58° N with drifts E and W at bottom. (McGregor 90:-632.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Lodi	Sec. 16, T 31 N, R 6 W, MDB&M	Undetermined	Vein 2 ft. wide with short ore shoot containing gold, silver, sphalerite and galena.	About 4 mi. N of Igo. Short adit. Small production. Idle. (Crawford 94:252, 96:361; Brown 16:791.)
	Lone Cedar				See Garfield.
	Los Andes				See Clipper and Snyder group.
	Lost Buck	T 31 N, R 8 W, MDB&M.	Undetermined	Vein 6 in. to 2 ft. wide strikes NW, dips 15° E.	6 mi. NW of Ono. Adit 200 ft. long giving 85 ft. of backs was stoped almost to surface. Idle. (Crawford 94:252; 96:361.)
	Lucky Boy (Red Cut)	Sec. 15, T 33 N, R 5 W, MDB&M	United States Government	Numerous quartz stringers with variable dips and strikes in Balaklala Rhyolite. 20 pockets in stringers said to have yielded $20,000.	Near Shasta Dam. Shallow cuts and shafts, adit 200 ft. long. Idle. (Averill 33:34–35.)
	Lyons Consolidated	Sec. 22, T 33 N, R 5 W, MDB&M	James P. Bradner, 140 Borica Street, San Francisco	Quartz vein	About 1 mi. N of Summit City. Some ore stoped and removed through adit years before 1932. Idle. (Averill 33:35.)
	Mad Dog	Sec. 10, T 32 N, R 6 W, MDB&M	Undetermined	Shear zone 45 ft. wide in fine-grained silicified metarhyolite includes quartz veins up to 3 ft. wide that contain a little fine gold.	About 2 mi. NE of Whiskeytown. Developed by hand-driven adit 146 ft. long. Idle. (Averill 33:35.)
	Maddox				See Mad Ox.
62	Mad Mule (Banghart)	Sec. 31, T 33 N, R 6 W, MDB&M	George S. Jackson, 18534 Vessing Rd., Los Gatos		(Hodson 93:397; Crawford 94:252; 96:361; Ferguson 14:52–54; Brown 16:791; Tucker 23:11; Logan 26:175; Averill 33:35–36; Kinkel et al. 56:51; Albers 65:33–34; herein.)
63	Mad Ox (Caribou Gold Mining and Power Company, Maddox)	Sec. 28, T 33 N, R 6 W, MDB&M	Mad Ox Mining Co., c/o Grace Schilling, 1044 Butte Street, Redding	Vein strikes N 27° E, dips 80° E to vertical in zone of intensely sheared greenstone up to 6 ft. wide. Balaklala Rhyolite is nearby, and where close to vein is silicified and partially replaced by calcite. Vein ranges from thin gouge streak to 4 ft. in width. 2 oreshoots reportedly exposed in crosscut adit, each 60 ft. long and up to 4 ft. wide, and a third 50 ft. long and 20 ft. wide, carrying $6–$8/ton in gold. 6-ft. barren vein at bottom of winze.	5 mi. N of Whiskeytown. 1,100 ft. of drifts from 900-ft. crosscut adit; 135-ft. winze from this level has 135-ft. drift at 90-ft. level, 100 ft. of drifting at bottom. Ore was treated in 10-stamp mill during 1930s. Mostly idle since 1911. (Fairbanks 93:397–398; Crawford 94:252; Ferguson 14:51; Brown 16:791–792; Averill 33:35; Albers 65:34.)
	Maduro	Sec. 20, T 32 N, R 5 W, MDB&M	Undetermined	4 parallel veins	About 1 mi. S of Keswick. Undeveloped. Idle. (Brown 16:792.)
	Mammoth	Sec. 4, T 32 N, R 5 W, & Sec. 33, T 33 N, R 5 W, MDB&M	United States Smelting Refining and Mining Company, Newhouse Bldg., Salt Lake City, Utah	Quartz vein averaging 8 ft. in width strikes N, dips 35° E.	About 6 mi. N of Redding, between Evening Star and Texas Consolidated groups. Active around and prior to early 1900s. 3 adits. Long idle. (Irelan 88:568; Fairbanks 93:397; Crawford 94:252; Diller 04:171.)
	Manlove	Sec. 32, T 33 N, R 6 W, MDB&M	Undetermined	Vein 2 ft. wide strikes NE, dips NW.	3½ mi. N of Whiskeytown. 45-ft. shaft and 2 adits 50 ft. long. Idle. (Crawford 94:252; 96:362.)
	Manzanita				See Ballou.
	Martin				See Truscott.
	Mascot	Sec. 22 or 27, T 32 N, R 6 W, MDB&M	Undetermined	2 veins in dark, fine grained, augite quartz diorite dike in lighter-colored quartz diorite; strike about N 55° E, dip 43°–70° S. Only 1 vein developed; consists of locally-crushed, manganese-stained, vuggy quartz with adjacent gouge. Pyrite commonly oxidized. 2 oreshoots 100 ft. long said to assay $11.85/ton.	About 2½ mi. SE of Whiskeytown. 2 adits; upper adit on vein for 200 ft. (Ferguson 14:49–50.)
	McCall	Sec. 32, T 36 N, R 5 W, MDB&M	Undetermined	Vertical vein 3 ft. wide strikes N 50° W between granodiorite footwall and slate hanging wall. Free gold in payshoot 27 in. wide, 80 ft. long.	About 2 mi. W of Delta. 4 adits at about 60-ft. intervals from 50 to 1,200 ft. long; 400 ft. of drifts. Small production. Idle. (Brown 16:792.)
	McCarthy, Saeltzer and Smith (G.A.R.)	T 32 N, R 5 W, MDB&M.	Undetermined	Vein 2 ft. wide strikes NW, dips 60° NE between slate walls. Quartz carries 1% sulfides and some gold telluride.	4½ mi. NW of Redding. Inclined shaft 40 ft. deep, 30-ft. open cut, and 40-ft. adit. Idle. (Crawford 96:361.)
	McKinnon	Sec. 6, T 35 N, R 5 W, MDB&M	United States Government	Vein 2 ft. wide in granodiorite strikes W, dips 70° N. Payshoot 2 ft. wide, 160 ft. long.	7½ mi. W of Delta. 3 adits 60 to 750 ft. long on vein. Idle. (Brown 16:792.)
	Mechado	T 31 N, R 6 W, MDB&M.	Undetermined	Vein carrying 10% sulfides strikes N.	3 mi. NE of Igo. 2 shafts about 14 ft. deep. Idle. (Crawford 94:252; 96:362.)
	Meeks	Sec. 15, T 32 N, R 5 W, MDB&M	Undetermined	Small vertical quartz vein at contact between Balaklala Rhyolite and Copley Greenstone.	About 3 mi. NW of Redding. Vertical shaft, caved in 1932. Ore was treated in 5-stamp mill. Idle. (Averill 33:36.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
64	Menzel (Bullard and Vandever, Santa Clara, Santa Rosa, Scottish Chief)	Sec. 31, T 33 N, R 5 W, & Sec. 6, T 32 N, R 5 W, MDB&M	Undetermined	Vein strikes N 85° E, dips 60°–70° S, is accompanied by fine-grained, pre-mineral, basic dike 1–2 ft. wide. Vein ranges from barren fracture to 6-ft. width of quartz enclosing stringers of country rock, can be traced on surface for 1,000 ft. White ribbon quartz in stope contains chalcopyrite. 18 tons sorted ore yielded $18/ton prior to 1932.	About 9 mi. NW of Redding. Some production 1880 or 1890 and early 1930s. Main crosscut adit 600 ft. long to hanging wall of vein 150 ft. below surface; 200 ft. drift to W with raise near face to intermediate level 35 ft. above. Drifts 140 ft. W and 25 ft. E of raise; stope 30 ft. high, 30 ft. long just above raise. Raise from W end of stope encountered old workings 20 ft. above. Gold recovered by amalgamation. Idle. (Crawford 94:259–260; 96:351, 368; Brown 16:797–798; Averill 33:37; 39:141.)
	Merry Mountain	Sec. 25, 36, T 33 N, R 7 W, MDB&M	Roy C. Skene, Schilling	A few quartz stringers and dikes of rhyolitic material in Copley Greenstone.	About 1½ mi. SE of French Gulch. 29,000 tons of surface material mined with power shovel; fines were screened and treated by amalgamation and on Wilfley tables. Plant closed after short operation in 1930s. Owners since have driven adit in gravel terrace in search of pay channel. Syndicate formed 1954 to prospect for uranium on the property; no discovery has been posted. (Averill 39:142.)
65	Midas (Gold Hill, Harrison Gulch, Victor and Twinvict)	Sec. 3, 4, 10, T 29 N, R 10 W, MDB&M	Adele Moore, 608 Mid Rincon Road, Santa Rosa		(Brown 16:792–793; Logan 26:173–174; Averill 33:31; 39:142; herein.)
	Milkmaid and Franklin				See Franklin and Milkmaid, herein.
	Miller				See Gold Leaf.
66	Milton (Hope So)	Sec. 31, 32, T 32 N, R 5 W, MDB&M	Alfred and Ray Leslie, Shasta		Herein.
	Miners Dream	T 31 N, R 6 W, MDB&M.	Undetermined	Vein 4 ft. wide strikes E, dips 50° N; carries some pyrite and copper sulfides.	3½ mi. S of Shasta. 40-ft. shaft with drift 40 ft. long at bottom, partly stoped for 30 ft. Idle. (Crawford 94:252–253; 96:362.)
67	Miners' group (Brunswick)	Sec. 19, T 33 N, R 7 W, MDB&M	Frank B. Russi, San Francisco		(Crawford 96:351; Ferguson 14:68; Brown 16:780; Averill 39:143–144; Albers 65:22; herein.)
	Minneshasta (Brackett)	Sec. 32, T 32 N, R 5 W, MDB&M	Undetermined	Quartz vein 6–7 ft. wide strikes N, carries sulfide ore; can be traced on surface for 3,000 ft.	About 2½ mi. W of Redding. Intermittently active 1890–1920s. 3 adits; upper 110 ft. long, middle 700 ft. long, lower 1,800 ft. long; 250 ft. of drifts on vein. Producer. Idle. (Diller 04:171; Laizure 21:523.)
	Minnesota (Rattler)	Sec. 1, 2, T 32 N, R 6 W, MDB&M	E. W. & Patricia O. Girard, Redding	Vein 4½ ft. wide strikes N 75° W, dips 70° N, is associated with sheared dikes of albite granite (?) in trondhjemite (?). Vein carries free gold, pyrite, and chalcopyrite.	2½ mi. SW of Matheson. Active 1890s; adit cleaned and retimbered 1930s. Extensive old workings; 1,200 ft. main adit with 700 ft. on vein. Ore first worked in arrastre, later in 10-stamp mill. Idle. (McGregor 90:625; Crawford 94:255; 96:363; Brown 16:794; Averill 33:37–38; 39:144–145.)
	Mocking Bird	T 31 N, R 7 W, MDB&M.	Undetermined	Vein 4–22 in. wide strikes NE.	14 mi SW of Redding. 80-ft. shaft with 2 drifts 20 ft. long at 40-ft. level. Idle. (Crawford 94:253.)
	Moline	T 32 N, R 6 W, MDB&M.	Undetermined	Veins averaging 30 inches in width strike NE, dip 45° SE.	3 mi. N of Shasta. Open cut 40 ft. long; adit 60 ft. long to vein and winze 10 ft. deep. Ore worked in arrastre driven by water power. Idle. (Crawford 96:362.)
	Molly Gibson	Sec. 4, 5, T 29 N, R 10 W, MDB&M	Undetermined	9 veins	About 1 mi. W of Knob. 7 claims. Developed by 1,000 ft. of adits. Idle. (Averill 33:38.)
	Montezuma				See Niagara group, herein.
	Morton & Bliss (Riley & Bliss)	Sec. 1, T 33 N, R 6 W, MDB&M	Carl O. Benson, 1610 North Norwendie Street, Los Angeles	2 parallel veins 3 ft. wide strike NE, dip 40° E. Free gold in payshoot 3 ft. wide, 200 ft. long.	About 4 mi. NW of Shasta Dam. 100 acres patented land. 2 adits on vein, 380 and 2,400 ft. long; 500-ft. drift, stope 200 ft. long, and raise. Ore worked in 10-stamp mill. Long idle. (Crawford 94:243; 96:362; Brown 16:794–795.)
	Mountain Queen	Sec. 30, T 32 N, R 5 W, MDB&M	J. C. & Myrtle Blankenheim, Redding	Nearly-vertical vein 4–8 ft. wide in quartz diorite strikes N 65° W. A second vein a few inches to 2 ft. wide strikes N 70° E and intersects first vein. Fine-grained basic dike is associated with one vein. Smaller vein said to yield $30/ton free gold, and larger vein to assay about $13/ton.	About 3 mi. SW of Whiskeytown. Active 1930s. 50-ft. shaft on larger vein, with 50 ft. of drifts at bottom; 30-ft. shaft on smaller vein. Idle. (Averill 33:39–40.)
	Mountain Top	T 32 N, R 6 W, MDB&M.	Undetermined	Vein 7–10 ft. wide strikes N, dips E.	5 mi. W of Redding. Drift 70 ft. long on vein. Idle. (Crawford 96:362.)
	Mountain View	Sec. 10, T 32 N, R 5 W, MDB&M	R. S. Ballou, Igo		8 mi. N of Redding. Prospect. Idle. (Tucker 22:354.)
	Mount Pleasant	Sec. 32, T 32 N, R 5 W, MDB&M	United States Government	Vein 3 ft. wide between slate and quartz porphyry strikes NW, dips 45° NE. Free gold in payshoot 3 ft. wide, 140 ft. long.	1 mi. W of Redding. 500-ft. adit and short drifts. Idle. (Brown 16:794.)
68	Mount Shasta	Sec. 34, T 32 N, R 6 W, MDB&M	H. H. Shuffleton, Jr., and Paulma Shuffleton, 2078 Butte Street, Redding	2 parallel veins 50 ft. apart strike N 20°–40° W in sheared mass of Balaklala Rhyolite in quartz diorite. Dip is steeply SW at surface, becoming steeply NE at depth. Intense alteration of metarhyolite within 15 ft. of	About 2½ mi. SW of Shasta. Discovered in 1897, active until 1905; again active 1911–13; idle since. Shaft 658 ft. deep with 7 levels; short crosscut at bottom. Several short adits. (Ferguson 14: 47–49; Brown 16:794; Averill 33:38; Albers 65:34.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Mount Shasta—Continued			veins consists of silicification or chloritization, with introduction of pyrite and calcite. Ore consists of locally-sheared white quartz containing pyrite and scattered calcite. Small specks of molybdenite were noted in quartz from the seventh level. Production through 1905 was 4,160 tons of ore yielding $178,000 (Ferguson).	
	Muletown Consolidated				See Potosi, herein.
	Murray	Sec. 18, T 32 N, R 5 W, MDB&M	Undetermined	Vein 6 ft. wide strikes N 40° E, dips 50° S, contains oreshoot 230 ft. long.	About 1½ mi. W of Keswick. 530-ft. adit, 200-ft drift and short raise. Idle. (McGregor 90:635; Crawford 94:253; 96:362; Brown 16:795.)
	N.R.A.				See Highland Lake.
69	National (Forbes, Veteran)	Sec. 23, T 33 N, R 5 W, MDB&M	Undetermined	Quartz vein 2½ ft. wide exposed in shaft contains abundant pyrite. Vein exposed in short adit reportedly yielded 48 tons of smelter ore containing $20–$24/ton, years prior to 1932. Total production of mine reportedly $200,000.	N of Summit City. Located 1869, active sometime prior to 1910; again active 1932–34. 1,200-ft. adit with 700-ft. winze comprise old workings, long caved. Later work in 1930s consisted principally of 50-ft. shaft N of limit of old workings, with short drifts at 25 ft.; 50-ft. adit, 200 ft. from shaft; and a small open cut. 250 ft. of workings are on the Veteran claim. Ore first worked in 10-stamp mill, later shipped to smelters. Idle. (Averill 33:40; 39:145–146.)
	Nellie and Annie	Sec. 1, 2, T 33 N, R 7 W, MDB&M	Undetermined	Vein 2 ft. wide strikes W, dips 60° S between slate footwall and granite porphyry hanging wall. Free gold in payshoot 2 ft. wide, 230 ft. long.	About 4 mi. N of French Gulch. 340-ft. adit with short drifts. Small production. Idle. (Brown 16:795.)
	Nelson	T 33 N, R 7 W, MDB&M	Undetermined	Quartz vein 1–2 ft. wide strikes NE.	7 mi. W of Whiskeytown on Grizzly Gulch. 2 adits 600 ft. apart, on vein. Idle. (Crawford 94:253; 96:362.)
	New Last Chance group	Sec. 7, T 30 N, R 7 W, MDB&M	Ace Merryfield, John Reed, Moses and Frank Grant, Redding		4 mi. W of Ono. 3 claims held by assessment work.
	New Year and Australian				See Australia.
	New York & Skylark	Sec. 17, T 33 N, R 7 W, MDB&M	Undetermined	2 parallel veins 200 ft. apart strike W, dip 60° N in slate. Free gold in low-grade payshoot 5 ft. wide, 180 ft. long.	3 mi. NW of French Gulch. 340-ft. adit on vein, winze 40 ft. deep, and a stope. Idle. (Brown 16:795.)
70	Niagara (Black Tom, Montezuma, Niagara Summit Mining Company, Scorpion) group	Sec. 7, 8, 17, 18, T 33 N, R 7 W, MDB&M	E. M. Clark, French Gulch, and Walter K. Jansen, Lincoln		(McGregor 90:636–637; Fairbanks 93:50–51; Crawford 94:253, 96:363; Ferguson 14:66–67; Brown 16:795–796, 799; Hamilton 22:19; Tucker 22:43, 296; Logan 24:15; Grant 32a; Averill 33:40–41; 39:146; Albers 65:27–28; herein.)
	Niagara Summit Mining Company				See Niagara group, herein.
	North Star	Sec. 18, T 31 N, R 6 W, MDB&M	Undetermined	Vein in granitic rock and slate. Short oreshoot has yielded a little high-grade ore.	3 mi. NW of Igo. Only slightly developed. Idle. (Brown 16:796.)
	North Star	Sec. 23(?), T 31 N, R 6 W, MDB&M	Undetermined	Vein 3 ft. wide strikes N 20° E, dips W in slate.	2¼ mi. NE of Igo. 90-ft. shaft on vein, with crosscut. Idle. (Crawford 94:253.)
	North Star	Sec. 6, T 32 N, R 6 W, MDB&M	Undetermined		3 mi. NW of Whiskeytown. Undeveloped prospect. Idle. (Laizure 21:523.)
	North Star and Elkhorn	Sec. 14, 15, T 31 N, R 6 W, MDB&M	C. G. George, C. Doebelin, et al., 1507 Union Street, Alameda	Quartz vein probably is same as at Potosi mine, which see.	2 mi. N of Igo, adjoining Potosi mine. 2 shafts, caved since early 1930s. Idle. (Averill 33:41.)
	North Star and Virginia	Sec. 8, 9, T 33 N, R 7 W, MDB&M	Undetermined	Quartz vein 8–12 in. wide strikes N, dips steeply E entirely within diorite dike that intrudes slate of Bragdon Fm.	2½ mi. NW of French Gulch, adjacent to Franklin mine. Upper development consists of 30-ft. crosscut adit and 300 ft. of workings, including stope 20 ft. long, 20 ft. high. 70 ft. below crosscut is adit driven 320 ft. E toward vein, which had not been cut by 1933. Idle. (Laizure 21:523; Averill 33:41.)
	Number 8				See Iron Mountain, herein.
71	Old Indian	Sec. 4, T 33 N, R 2 W, MDB&M	F. J. Ward	Veinlets and blebs of galena, chalcopyrite, sphalerite, and pyrite in 3 quartz veins trending W in Bully Hill Rhyolite. Small pocket in vein reportedly yielded $47,000 in gold.	NW of Ingot. Several pits and short adits. (Albers and Robertson 61:101.)
	Old Mine				See Iron Mountain, herein.
72	Old Spanish (Deakin and Taylor, Enright)	Sec. 31, T 32 N, R 5 W, MDB&M	Cassie M. Middletown, Redding		(McGregor 90:632; Crawford 94:246–247; 96:353; Brown 16:796; Averill 33:42; Hollister 49; herein.)
	Olive	Sec. 19, T 32 N, R 5 W, MDB&M	Undetermined	3 parallel veins with granitic footwall and schist hanging wall. Free gold in low-grade oreshoot 6 ft. wide, 230 ft. long.	About 4½ mi. NW of Redding. Ore was treated in 4-stamp mill. Small production. Idle. (Brown 16:796.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
73	Original Quartz Hill (Consolidated Kascinaska, Consolidated Kosciusko, Koskiusco, Quartz Hill)	Sec. 10, 11, 15, T 32 N, R 5 W, MDB&M	O. H. and Charlotte Short, Box 2257, Buckeye Rt., Redding	2 parallel veins 35 ft. apart strike N 40° W, dip 50° W in Copley Greenstone. Main vein 36 ft. wide has 5–6 ft. high-grade ore showing wire gold, pyrite, native copper and silver, and silver chloride. Bullion contained gold and silver in ratio of 1.6:1. Low-grade ore used for smelter flux 1904–06; sold for $2/ton with gold values extra.	4 mi. NW of Redding. Located 1868, relocated 1884. Purchased 1893 by Original Quartz Hill Gold Mining Co. Ore worked in 10-stamp mill, then 20 stamps by April 1896. Idle mid-1896 to late 1903. Leased to Mammoth Copper Company 1906–18, but idle beginning around 1908. Crosscut adit about 170 ft. long, and winze 47 ft. deep with drift near bottom. 61-ft. vertical shaft, several other adits 50–480 ft. long, and benched quarry on outcrop. (Irelan 88:570; Crawford 94:254; 96:352; Brown 16:783; Tucker 22:354; Lydon 61:23–29.)
74	Oro Fino	Sec. 34, 35, T 32 N, R 6 W, MDB&M	Mrs. Edna Behrens Eaton, 1530 West Street, Redding	2 parallel veins strike W, dip 60° S. Payshoot 2 ft. wide, 200 ft. long carried free and sulfide gold. Geology similar to that of adjoining Mount Shasta mine, which see. Approximately 200 tons ore shipped to Mountain Copper Co. in 20 lots yielded $4.40–$70.40/ton; most lots yielded $20–$30/ton. Silver averaged about 1 oz./ton.	About 2 mi. SW of Shasta. About 1,000 ft. of old workings are caved. Long idle. (Fairbanks 93:44; Brown 16:796; Averill 33:42.)
75	Oro Grande	Sec. 5, T 31 N, R 5 W, MDB&M	George F. McGinnis, et al.; address unknown	Network of steeply-dipping quartz veins in greenstone; widths range from gouge seam to 2 ft. Open cuts expose network in 40 acres. Oreshoot 36 ft. long above 50-ft. level reportedly yielded $15,000 prior to 1930. Veins said to assay $4–$7/ton in gold.	About 4 mi. W of Redding. 63-ft. shaft with drifts 137 ft. N and 181 ft. S at 50-ft. level, 2 crosscuts 20 ft. long, and a raise to surface from N drift. Several thousand feet shallow trenches on surface. Idle. (Averill 33:42–43.)
	Peerless				See Anavina.
	Philadelphia and Roosevelt				See St. Jude, herein.
	Phoenix	Sec. 15, 16, T 32 N, R 6 W, MDB&M	Ray P. and Evelyn Hurlbut, Redding	Quartz vein 14 ft. wide and parallel vein 3 ft. wide strike W, dip 65° N. Branch vein 3 ft. wide strikes N 35° W. Main vein said to assay $4/ton and to contain bunches of higher grade ore.	1 mi. E of Whiskeytown. Active 1886–88, when 5-stamp mill used. Siliceous ore hauled to Bully Hill smelter 1893. Caved adit 700–800 ft. long, open cut. Idle. (Averill 39:148.)
	Porcupine group	Sec. 35, T 32 N, R 6 W, MDB&M	Nora E. Mallett; address unknown		2½ mi. SE of Shasta. Considerable equipment installed in early 1930s to work a surface area thought to contain a profitable quantity of gold. Only a small amount of material was milled and the plant was dismantled. (Averill 33:44)
76	Potosi (Muletown Consolidated, Spring Gulch Mining Company)	Sec. 15, 22, T 31 N, R 6 W, MDB&M	Norman Lane, Knob Rt., Redding		(Crawford 94:254; 96:363; Brown 16:796–797; Averill 33:44–45; 39:149; Albers 65:31; herein.)
	Pugh and Lindsay	Sec. 27, T 32 N, R 6 W, MDB&M	Undetermined	3 parallel veins strike W, dip 55° N; a fourth vein strikes NE. All are in metarhyolite.	2 mi. W of Shasta. 60-ft. shaft on one vein, adits 60 and 40 ft. long on 2 others. Ore was worked in Kendall rocker mill. Idle. (Crawford 94:254; 96:363.)
	Quartz Hill				See Original Quartz Hill.
	Rattler				See Minnesota.
	Rattlesnake (Scorpion, Spider)	Sec. 5, T 31 N, R 5 W, MDB&M	John W. Sanders, 1go Rd., Redding	Quartz veins up to 8 ft. wide in greenstone are associated with NW-trending fault, contain some free gold.	4 mi. SW of Redding. Several surface cuts, several hundred feet of crosscut adits, including one 400 ft. long. Idle. (Averill 33:46.)
	Rawhide	Sec. 19, T 32 N, R 5 W, MDB&M	Undetermined	Quartz vein 2½ ft. wide contains free gold.	About 1½ mi. SW of Keswick. Discovered 1920. Undeveloped. (Laizure 21:523.)
	Red Bluff	Sec. 16(?), T 31N, R 8 W, MDB&M	Undetermined	Vein 6–8 ft. wide.	15½ mi. NW of Ono, adjoining Cleveland Consolidated mine. Adits 150, 60 and 30 ft. long, and shallow winze. Idle. (Crawford 96:363.)
	Red Cloud	T 31 N, R 7 W, MDB&M.	Undetermined	Vein 8 in. wide in granite strikes E, contains abundant sulfides. Sorted ore assayed $300/ton.	4 mi. W of Igo. 50-ft. adit to vein with 50-ft. drift. Idle. (Crawford 94:255; 96:363.)
	Red Cut				See Lucky Boy.
	Redding Consolidated of Nevada				See Boswell.
77	Reid	Sec. 3, 4, T 32 N, R 5 W, & Sec. 34, T 33 N, R 5 W, MDB&M	Brayton Wilbur, Marie Shelton, 430 California Street, San Francisco; and L. R. Erich, Box 66, French Gulch		(Brown 16:797; Tucker 22:408; 23:11; Logan 24: 15; 26:176–178; Averill 33:46–49; 39:146–147; Kinkel et al., 56:52; herein.)
	Remonia				See Colorado.
	Reservoir and offset				See Black Cloud and Red Cloud.
	Richmond	Sec. 19, 20, T 31 N, R 7 W, MDB&M	Bertha F. Johnston, Redding	Vein 6–8 in. wide strikes NE, yielded sulfide ore containing gold and silver.	3½ mi. NW of Igo. Shafts 40, 60, and 80 ft. deep with some drifting. Producer. Idle. (Crawford 94: 256; 96:364.)

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Richstrike				See Yankee John.
	Rickard	Sec. 1, 2, T 35 N, R 6 W, MDB&M	Regis E. Halter, 2346 Placer Street, Redding	Vein strikes W, dips 60° S.	4½ mi. W of Delta. 9 patented claims. Adit 240 ft. long. Idle. (Crawford 96:364.)
	Riley and Bliss				See Morton and Bliss.
	Salt Creek group				See Bonanza.
	Sam Houston	Sec. 34, T 33 N, R 5 W, MDB&M	Victor M. Gold, Redding	3 quartz veins a few inches to 3 ft. wide; one is associated with a rhyolitic dike in Copley Greenstone. 14-in. vein said to have assayed $10.10 in 1932. 18-in. vein reportedly yielded ore in early 1900s.	About ½ mi. W of Churntown. Last active 1907, except for assessment work. Surface cut, several short shafts and adits; one 380-ft. adit did not reach vein. Idle. (Brown 16:797; Averill 33:48.)
	Sanders and Vollmer	T 36 N, R 6 W, MDB&M.	Undetermined	2 parallel veins about 2 ft. wide strike W, dip 60° S.	On Dog Creek 5½ mi. W of Delta. 3 adits 40, 150, and 100 ft. long. Idle. (Crawford 96:364.)
	Santa Clara				See Menzel.
	Santa Rosa				See Menzel.
	Scharrell				See Hall Brothers.
	Schwab and Taylor				Operated several mines in Old Diggings district under lease in 1938–1939. Main Texas level was cleaned out for 1,500 ft.; part of lowest Central adit was cleaned; part of Reid shaft was retimbered; and main Evening Star adit was driven N at 1,500-ft. point in search of oreshoot found in upper portion of old workings. Attempts to treat dump ore from Evening Star by flotation were unsuccessful, partly because of slightly weathered (oxidized) condition of sulfides. (Averill 39:147–148.)
	Scorpion				See Niagara group, herein.
	Scorpion				See Rattlesnake.
	Scottish Chief				See Menzel.
	Sebastian Mining Company				See Yankee John.
	Shasta Hills				See Sybil.
	Shasta Mining Association				See Yankee John.
	Shasta Monarch Mining Company				See Gambrinus.
	Shasta View (Bonanza Gold Dollar)	Sec. 26, 27, 34, 35, T 32 N, R 6 W, MDB&M	Undetermined	Quartz lenses a few inches to 1 ft. wide occur in a NE-trending shear zone in a fine-grained rhyolitic dike in quartz diorite, together with considerable disseminated pyrite.	2 mi. W of Shasta. Some older, caved workings. 21 claims and a mill site. 512-ft. adit on shear zone. Idle. (Tucker 22:256; Logan 24:15; Averill 33: 48–49.)
	Shirttail	Sec. 1, T 33 N, R 7 W, MDB&M	Undetermined	Copley Greenstone country rock.	NNE of French Gulch, about 1 mi. W of Shirttail Peak. Long idle. (Ferguson 14:69.)
	Sierra Buttes Mining Company				See Uncle Sam, herein.
	Siskiyou and Nightingale	Sec. 2, T 35 N, R 6 W, MDB&M	Undetermined	5 veins. Main vein strikes W, dips vertically between slate and greenstone. Free gold in payshoot 3 ft. wide, 450 ft. long.	5 mi. W of Delta. 5 adits on main vein, 100–500 ft. long. 4 drifts. Idle. (Brown 16:798.)
	Slatonas	T 36 N, R 5 W, MDB&M.	Undetermined	Vein 2 ft. wide strikes N, dips 80° E.	On McCall ranch, 4 mi. W of Delta. Adits 30, 100, and 256 ft. long. Idle. (Crawford 96:364.)
	Slide	Sec. 7, 8, T 32 N, R 5 W, MDB&M	Iron Mountain Investment Company, 230 California Street, San Francisco	Vein in granite porphyry contains payshoot 2 ft. wide, 110 ft. long.	1 mi. N of Keswick. 700-ft. adit on vein and 600 ft. of drifts. Idle. (Brown 16:799.)
	Snyder				See Clipper and Snyder.
	South Star	Sec. 32, T 33 N, R 7 W, MDB&M	Undetermined		In French Gulch district about 1½ mi. W of Tower House. Prospect located in mid-1922. Idle. (Tucker 22:256.)
	Spanish				See West End.
	Sp. dy	Sec. 8(?), T 32 N, R 5 W, MDB&M	Undetermined	Vein 7 ft. wide strikes W, dips 45° S.	On Flat Creek 3½ mi. S of Keswick. Crosscut adit 450 ft. to vein, with drift 500 ft. long mostly stoped to surface. Idle. (Crawford 94:257; 96:364.)
	Spider				See Rattlesnake.
	Spring Gulch	Sec. 7, T 33 N, R 5 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	Vein 2 in. to 1 ft. wide strikes N, dips E.	3 mi. NW of Shasta Dam. Adits 40, 50, and 212 ft. long. Idle. (Crawford 94:257; 96:364.)
	Spring Gulch Mining Company				See Potosi, herein.

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Stacey	Sec. 9, T 35 N, R 6 W, MDB&M	Undetermined	Vein 1–8 ft. wide strikes N 15° W in greenstone that is intensely altered near the vein. Flat-lying mass of albite granite exposed in lower crosscut. Vein is terminated on N by vertical fault striking N 30° E. Ore consists of manganiferous quartz without pyrite. Pockets of gold occur closely associated with patches or streaks of manganese oxide, and have yielded $45,000.	About 9 mi. SW of Delta, adjacent to Copper Snake mine. At least 2 crosscuts. Active in 1913. Idle. (Ferguson 14:73.)
	Star Gulch Mining Company				See Walker, herein.
	Stella				See Little Judy group.
78	St. Jude (Philadelphia and Roosevelt, Vogt)	Sec. 17, T 33 N, R 7 W, MDB&M	St. Jude Mining Company, 4182 Greenwood Ave., Oakland		(Averill 33:43–44, 39:152; Goodwin 57:693; Albers 65:28; herein.)
	Stony Gulch				See Great Western
	Summit				See Sunny Hill
79	Summit	Sec. 19, T 33 N, R 7 W, MDB&M	Marian G. Fondahn, French Gulch; leased to Don Carlson, French Gulch	Sheared slate of Bragdon Formation is cut by 3 small dikes of "birdseye" porphyry. Quartz veins a few inches to 2 ft. thick cut the dikes and strike N to N 25° E. The main vein (Brown) dips 40°–65° E. A fault striking N 30° W, dipping 50° SW, truncates Brown vein in western part of mine. Ore localized by veins with opposing dips. Best ore occurs near porphyry dikes. Gold occurs with sphalerite, pyrite, galena, and arsenopyrite in the veins near their contacts. Sphalerite is the principal sulfide. Arsenopyrite occurs in the porphyry dikes as well as in the veins.	In Summit Gulch, 3 mi. W of French Gulch. Located prior to 1896, by which time a few hundred feet of drifts, crosscuts, and shafts had been driven and a 5-stamp mill erected. Ore milled at Washington mill in 1910s, and at Brunswick mill in 1920s. Adits 100 and 400 ft. long driven on vein during 1930s; drifts and winzes were driven, and ore valued at $6–$8 per ton was mined. Production estimated at $30,000 between 1907 and 1912, $200,000 total (Ferguson, 1914, p. 67). Only small-scale activity since 1942. (Crawford 96:365; Ferguson 14:67; Brown 16:799; Tucker 22:206, 256; 23:11; Averill 33:49–50; 39:152–153; Albers 65:29.)
	Sunday Gulch (Victor Mining Company)	Sec. 10, T 29 N, R 10 W, MDB&M	Undetermined	4 parallel veins strike N 70° E, dip 45° S. One vein, 4 ft. wide between slate footwall and diabase hanging wall, assayed $8.00/ton in gold.	In Harrison Gulch, near Knob. Short adits. Active around 1913. Idle. (Brown 16:799.)
	Sunny Hill (Gray Eagle, Summit)	Sec. 1, T 30 N, R 8 W, MDB&M	Sunny Hill Mining Company, 341 Broadway, San Francisco	Vertical vein 1–4 ft. wide strikes N at contact between hornblende schist and granite porphyry. Free and sulfide gold in near-surface payshoot 80–100 ft. long.	5 mi. NW of Ono. Producer during 1890s, active 1910s and early 1930s. 530-ft. adit, 300 ft. of drifts, and a stope comprise old workings; 800-ft. lower adit driven early 1930s. Idle (Crawford 94: 257; 96:365; Brown 16:799; Averill 33:50.)
	Sunshine				See Kanaka.
	Surprise	Sec. 19, T 32 N, R 5 W, & Sec. 24, T 32 N, R 6 W, MDB&M	Jeanfay Corporation, 1621 No. Cahuenga Boulevard, Hollywood 28	Quartz vein 12 ft. wide strikes N 58° E, contains sulfides.	1¾ mi. N of Shasta. Shaft 50 ft. deep. Idle. (Crawford 94:257.)
80	Sybil (Accident, Anaconda, Shasta Hills)	Sec. 7, T 33 N, R 7 W, MDB&M	Lionel Von Krusze, Box 363, Central Valley	Nearly-vertical veins of blue-gray quartz associated with a slate-diorite porphyry contact that strikes N 80° W and dips 50° N (Ferguson) or perhaps locally to the S (Averill, 1933). Veins strike NE (Averill, 1933). S-dipping contact at winze formed locus for oreshoot that rakes southward. Ore contains arsenopyrite, pyrite, galena, and sphalerite. Visible gold is associated with galena. Oreshoot at winze reportedly was 90 ft. long, averaged 4 ft. in width; yielded ore ranging from $30–$60/ton, averaging $40/ton in 1926.	4 mi. NW of French Gulch. Extensive workings by 1913. Idle for indefinite time until 1921–23, when Shasta Hills Mining Co. and lessees extracted from lower levels some rich ore that was treated in 5-stamp mill. Idle again until early 1930s, when small production made from sixth level, and another adit driven. Small-scale work done in late 1930s. Assessment work only, in recent years. Workings consist of 6 adit levels that developed vein to depth of 200 ft. Sixth level was driven S 75° E for 700 ft.; 150-ft. winze was sunk on vein, with drifts 175 ft. E and W, 80 ft. below the level. Old workings were above sixth level and W of a fault exposed in it; later work on sixth level and in winze was E of fault. Accident tunnel was driven for 800 ft., 540 ft. below the sixth level, in early 1930s. (Ferguson 14:68–69; Brown 16:777; Tucker 22:43, 138, 296, 408; 23:11; Logan 26:178–179; Averill 33:50–51; 39:153; Albers 65:19.)
	Sysonby				See Tom Green.
	Tabowie Mines, Incorporated	Sec. 10, 15, 16, T 33 N, R 7 W, MDB&M	Undetermined	Quartz stringers associated with fine-grained quartz diorite dikes in Bragdon slate.	1 mi. NW of French Gulch. Adit driven N 22° W for 400 ft. to prospect a large group of claims. Idle since 1933. (Averill 39:153.)
	Tanglefoot	Sec. 12, T 30 N, R 8 W, MDB&M	Undetermined	2 parallel veins 200 ft. apart strike N 40° W, dip 50° E. High-grade, free gold in payshoot 10 in. wide, 60 ft. long.	5 mi. W of Ono. 450-ft. adit. Some production. Long idle. (Brown 16:799–800.)
	Telluride Consolidated				See Eureka Tellurium.

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
81	Texas Consolidated	Sec. 4, T 32 N, R 5 W, & Sec. 32, 33, T 33 N, R 5 W, MDB&M	Evelyn P. Joslyn et al., 99 Highland Ave., Oroville		(Fairbanks 93:43; Hodson 93:395, 396–397; Crawford 94:258; 96:365; Brown 16:800; Tucker 22: 206; 23:11, 58, 137; Logan 26:179; Averill 33: 51–52; 39:146–148; herein.)
	Thompson	T 31 N, R 6 W, MDB&M.	Undetermined	Vein 3 ft. wide strikes W, dips 50° N.	2½ mi. SW of Shasta. Inclined shaft 80 ft. deep is intercepted by adit 125 ft. long on the vein. Sorted ore was shipped. Idle. (Fairbanks 93:40; Crawford 94:258; 96:367.)
	Three Sisters	Sec. 15, T 33 N, R 7 W, MDB&M	Undetermined	3 veins associated with fault zone that strikes N 50° E, dips 70° N in Bragdon Fm. Veins consist of ribbon quartz and some calcite in sheared quartz porphyry; pyrite and arsenopyrite are present. Stoped oreshoot was 18 in. wide, contained free gold.	About 1 mi. N of French Gulch. Discovered 1895, producer to 1905. 1,350-ft. adit, 800 ft. of drifts, stope 200 ft. long, and 200-ft. winze by 1913. Gold recovered by amalgamation in Huntington mill. Idle. (Crawford 96:367; Ferguson 14:69; Brown 16:800; Albers 65:29.)
	Tom Cook				See Whiskey Hill, herein.
82	Tom Green (Green, Honey Bee, Sysonby, Twenty Grand)	Sec. 18, T 33 N, R 7 W, MDB&M	Donald Vernon, and Alvin Fox, French Gulch	3 parallel veins strike N, dip 45° E. Oreshoot 2 ft. thick on one vein was stoped for 550 ft. along rake (to NE), and for 150 ft. vertically at right angles to rake.	About 3½ mi. NW of French Gulch. Discovered 1887, producer 1890–1913, active late 1930s. Vein mined by 3 adits 100 ft. apart vertically; lengths in Tom Green property range from 280–460 ft., and all pass into Summit workings adjoining on S. Ore worked in 10-stamp mill. Idle. (Crawford 94:249; 96:358; Brown 16:800; Averill 33:52; 39:154; Albers 65:29.)
	Topknot	T 36 N, R 6 W, MDB&M.	Undetermined	3 parallel veins average about 2½ ft. in width.	5½ mi W of Delta. Adits 45 and 100 ft. long, some stoping. Ore worked in arrastre. Idle. (Crawford 96:367.)
	Trinity Consolidated	Sec. 1, 2, T 35 N, R 6 W, MDB&M	H. S. and J. A. Anderson, San Juan Bautista	6 vertical, parallel veins strike W between slate and greenstone. Payshoot on one vein 3 ft. wide, 450 ft. long, contained free gold.	4 mi. SW of Delta. 120 acres patented. Several adits 50–450 ft. long, also drifts, raises, and stopes; maximum depth of workings 160 ft. 10-stamp mill built 1900. Small producer 1900s. (Irelan 88:569; Crawford 96:367; Brown 16:802.)
83	Truscott (Emigrant, Iron Mask, Martin)	Sec. 36, T 33 N, R 7 W, MDB&M	Undetermined	Large lenses of quartz occur along footwall of a dike of "birdseye" prophyry 300 ft. wide. Contact strikes N 20° E, dips 60–80° W. Only lens developed was 100 ft. long, had width ranging from gouge seam to 10 ft. Quartz carries pyrite, copperstains, and $10–$15/ton in free gold. Small vein 4–8 in. wide at upper level branches into the porphyry; oxidized ore here reportedly showed $100–$300/ton by panning. Total production to 1912 was $60,000 (Ferguson) or $100,000 (Albers).	2 mi. E of Tower House. Discovered around 1887, intermittently active to 1913. 4 adits 40 ft. apart on vein and 50–60 ft. long; also drifts and a stope. 300 ft. of new drifting in early 1930s reached barren contact. Idle. (Irelan 88:571–572; Crawford 94: 248; 96:356; Ferguson 14:54–55; Brown 16:802; Averill 33:53–54; Albers 65:34.)
	Twenty Grand				See Tom Green.
84	Uncle Sam (Sierra Buttes Mining Company, Vera Mines)	Sec. 1, T 33 N, R 6 W, & Sec. 6, T 33 N, R 5 W, MDB&M	Fred H. Dakin et al., c/o 2811 Hillside Dr., Burlingame		(McGregor 90:639; Fairbanks 93:47; Hodson 93: 395, 398; Crawford 94:258–259; 96:367; Diller 04:171–172; Brown 16:802–803; Averill 33: 54–55; 39:154; Kinkel et al., 56:21, 26, 51, 59, 67; herein.)
	Utah and California				See Walker, herein.
	Vera Mines				See Uncle Sam, herein.
	Veteran				See National.
	Victor and Twinvict				See Midas, herein.
	Victor Mining Company				See Sunday Gulch.
	Vogt				See St. Jude, herein.
	W and W				See Willard and Williams.
85	Walker (Dowling Mining and Investment Company, Josephine and Providence, Star Gulch Mining Company, Utah and California)	Sec. 3, 4, T 32 N, R 5 W, MDB&M	John Pearl, 4019 McKinley Blvd., Sacramento		(McGregor 90:630–631; Hodson 93:397; Crawford 94:259; 96:368; Brown 16:803; Averill 33:56; 39:154–156; Kinkel et al. 56:12; herein.)
	Walker	Sec. 30(?), T 32 N, R 5 W, MDB&M	Undetermined	Pocket yielded 4-3/8 lbs. gold in 1922, worth $1,000.	On Middle Fork of Salt Creek, 4 mi. W of Redding. Worked by Frank Walker in 1920s. Idle. (Tucker 22:296.)
86	Washington	Sec. 16, 17, T 33 N, R 7 W, MDB&M	J. H. Scott, 11 Corte Encanto, San Rafael		(McGregor 90:635–636; Fairbanks 93:50; Crawford 94:260; 96:368; Ferguson 14:64–66; Brown 16:804; Tucker 22:43; 23:11; Logan 26:179–180; Averill 33:57; 39:156–159; Albers 65: 30–31; herein.)
	We Hope				See Horstman.

GOLD—LODE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Wertz	Sec. 17, 18, T 33 N, R 7 W, MDB&M	E. M. Clark, French Gulch.	2 quartz veins 50 ft. apart strike N 55° E, dip 80° N in Bragdon slate. Another vein strikes N 10°–20° W, dips 80° W; it intersects northern of parallel veins.	About 3 mi. NW of French Gulch. 450 ft. of workings, on 3 levels. Small production. (Albers 65:25.)
87	West End (Spanish)	SE¼ Sec. 16, T 32 N, R 6 W, MDB&M	U.S. Government; leased to Gus Herman, Whiskeytown (1962)	West End vein strikes NNW, dips 70° E; Spanish vein strikes N 27° E, dips 80° W. Veins intersect N of shaft, range from a few inches to 2 ft. wide. Metarhyolite near veins is sheared and silicified or chloritized. Ore consists of white quartz containing pyrite and free gold. New oreshoot occurs in vein striking N 50° W, dipping 70° N in sulfide-rich metarhyolite; yielded $3,000 by crude milling, according to Herman. 80% of gold is in sulfides, 20% free.	½ mi. E of Whiskeytown site Active 1920s. Held by Gus Herman during 1950s. Leased to him after acquisition by U.S., and subleased in 1962. 100-ft. vertical shaft with 110-ft. crosscut drift to West End vein and 215 ft. of drifting on 31-ft. level; 100-ft. crosscut driven N 45° E from vein to Spanish vein, with 105 ft. of drifts on it. At 100-ft. level, 200 ft. of drifts on West End vein. 80-ft. crosscut adit driven N 80° E to Spanish vein, beginning 130 ft. N of shaft. Stope 60 ft. long on Spanish vein. New oreshoot found by Gus Herman 500 ft. W of shaft, developed by adit with short stope to surface. (Crawford 94:260; 96:368; Tucker 22:96, 256, 295–296; 23:11; Logan 26:180.)
	West Point	T 32 N, R 6 W, MDB&M.	Undetermined	Vein 20 in. wide strikes W, dips N.	3½ mi. W of Shasta. 40-ft. inclined shaft and an adit. Idle. (Irelan 88:570; Crawford 94:260; 96:368.)
	Western				See Franklin and Milkmaid, herein.
88	Whiskey Hill (Tom Cook)	Sec. 28, T 33 N, R 6 W, MDB&M	Archie Adams, Hayfork		Herein.
	White Oak	Sec. 32, T 32 N, R 6 W, MDB&M	Henry Carter, et al., French Gulch	Vein 5 ft. wide strikes W, dips 40° S.	2½ mi. SE of Shasta. Located in 1882. Idle. (Irelan 88:571.)
	Willard and Williams (W and W)	Sec. 19, T 32 N, R 5 W, MDB&M	Undetermined	Vein 6 in. to 4 ft. wide strikes N 70° E, dips 65° N.	About 1 mi. W of Keswick. Surface cut 50 ft. long and shaft 15 ft. deep. Idle. (Laizure 21:523–524.)
	Willow Creek Mines (Greenhorn)				See Greenhorn mine in copper section, herein.
	Winnie				See East View.
	Woodfill (Beaver)	Sec. 7, T 30 N, R 7 W, MDB&M	Clarence Crawford, address unknown	Vein about 1 ft. wide strikes N, dips 80° E in serpentinized schist. Ore consists of mixture of quartz and country rock containing calcite, free gold, pyrite, minor amounts other sulfides, and possibly some tellurides. 800 lbs. sorted ore returned $69.97/ton from Selby smelter, and 7-ft. width of material largely country rock at bottom of winze said to assay $9.30/ton in 1932.	3½ mi. W of Ono. 76-ft. crosscut adit with drifts 76 ft. S and 26 ft. N, and winze 15 ft. deep. Crosscut adit 84 ft. below first adit was driven 146 ft. to point 70 ft. from vertical projection of winze. Idle. (Averill 33:9–10.)
	Worlds Fair	T 31 N, R 6 W, MDB&M.	Undetermined	Vein 3–9 ft. wide contains pyrite and strikes N 20° E, dips slightly W between slate and porphyry walls.	2½ mi. NE of Igo. Adit 130 ft. long. Idle. (Crawford 94:260; 96:368.)
	Yankee Jack				See Yankee John.
89	Yankee John (Richstrike, Sebastian Mining Company, Shasta Mining Association, Yankee Jack)	Sec. 17, T 31 N, R 5 W, MDB&M	Maurine Herrmman, 2611 Land Park Drive, Sacramento		(Laizure 21:524; Tucker 22:495; 23:11; Averill 33:57–58; 39:150; O'Brien 51:371; herein.)
	Yellow Jacket	T 33 N, R 5 W, MDB&M.	Undetermined	Quartz vein carrying auriferous galena and pyrite strikes W.	3 mi. NE of Copley. Open cut and 50-ft. crosscut adit. Idle. (Crawford 94:260; 96:368.)

GOLD—PLACER

	A. C. Mining Company	Sec. 2, T 32 N, R 5 W, MDB&M	Janie Williamson, Buckeye Rt., Redding	11 ft. of gravel over porphyry.	A 1½-cu.-yd. dragline and dredge with 710 sq. ft. of sluices operated near Buckeye in early part of 1937. Water available winter and spring. 1,900 cu. yds. gravel washed each 19-hr. day. Dragline and washing plant cost $53,670, and operating cost was 11 cents/yd. (Gardner and Allsman 38; Averill 38a:114.)
	American Gold Dredging Company	Sec. 25, 26, T 32 N, R 5 W, MDB&M		At Redding, values low and spotty in medium-sized gravel 20–40 ft. deep. Ground near Gardella averaged 10 cents/yd. in 1917.	Along the N bank of Sacramento River at Redding. Bucketline dredge operated intermittently 1918–23. Held 250 acres near Gardella operation, which see. Disbanded. (Logan 18:37, 38; 26:189–190.)
	Auclair dredge	Sec. 12, T 32 N, R 7 W, MDB&M	E. Auclair, Whiskeytown		About 1½ mi. SE of Tower House. Small suction dredge operated on Clear Creek by owner for short time in 1947. Dismantled. (O'Brien 48:357–358.)
90	B.H.K. Mining Company	Sec. 34, T 32 N, R 6 W, MDB&M	Robert Litsch and Roy Connelly, Shasta		(Averill 46:283; herein.)

GOLD—PLACER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Baker, M. D.	Sec. 34, T 32 N, R 6 W, MDB&M			On Clear Creek, about 2½ mi. S of Whiskeytown. Gravel mined with power shovel washed in "dry-land dredge" in 1937. Dismantled. (Averill 38a: 114.)
	Battams	Sec. 11, T 32 N, R 5 W, MDB&M	Margaret Battams, Buckeye Road, Redding		At Newtown. Creek bed dredged by Roy S. Olson in 1947.
	Behre	Sec. 24, T 31 N, R 6 W, MDB&M	Dale Stott, Igo Road, Redding	Scattered colors distributed evenly throughout vertical extent of Red Bluff Fm. gravel, according to owner.	About 2½ mi. NE of Igo. Small scale placer mining. Idle.
	Betty Jean	Sec. 32, T 33 N, R 6 W, MDB&M	Gus Herman, Whiskeytown	Gravel 1–20 ft. deep on 28,000 sq. yds. of ground. Some color found 200 ft. higher than present channel, according to owner.	3½ mi. N of Whiskeytown, at junction Mad Ox Gulch and Whiskey Creek. Small-scale placer mining since 1958.
	Big Chief and Little Chief	Sec. 36, T 31 N, R 6 W, MDB&M	Undetermined		At Horsetown, 6½ mi. W of Girvan. Gravel prospected by 15 holes about 20 ft. deep. Idle. (Logan 26:187–188.)
	Blue Bird				See Russell, herein.
	Blue Bird No. 1 & 2	Sec. 15, T 31 N, R 5 W, MDB&M	Jess Barnes, et al.; address unknown		In Oregon Gulch about 3 mi. S of Redding. 2 claims.
	Blue Gravel				See under lode gold, herein.
	Brennan Dredge	Sec. 21, T 31 N, R 5 W, MDB&M			J. P. Brennan of Redding operated dragline dredge on Tadpole Creek 4 mi. SW of Redding, January to October 1940, then at Champion Gulch until June 1941. Dismantled. (Averill 46:283.)
	Bull Pine and White Horse				See Last Chance No. 1 & 2.
	Carlson and Sandburg	Sec. 23, 31, T 31 N, R 5 W, & Sec. 23, T 32 N, R 5 W, MDB&M			7½ mi. SW and 1½ mi. N of Redding. Operated 3 draglines with Bodinson washing plants in Olney, Clear, and Sulphur Creeks in 1937. Dismantled. (Averill 38a:114.)
	Channel Placers				See Dixon and Cooper.
	Chapman and Voluntines				See Dixon and Cooper.
91	Clear Creek Dredging Company	Sec. 2, T 29 N, R 6 W, & Sec. 28, T 31 N, R 5 W, MDB&M	George Bibbens and Dave Hinds, Box 598, Redding		(Averill 46:283; herein.)
	Clear Creek Placer Company	Sec. 34, T 32 N, R 6 W, MDB&M	Florence Brady, French Gulch		About 3 mi. SE of Whiskeytown. Gravel on Clear Creek was mined with power shovel and washed in plant mounted on skids; accumulation of tailings interfered with operation. Disbanded. (Averill 33:60.)
	Columbia Construction Company	Sec. 31, T 32 N, R 4 W, MDB&M	Frances Kutras, East Butte Street, Redding; leased by Redding Sand and Gravel Company, Redding	4,038,167 tons sand and gravel yielded 2,810 oz. gold, 301 oz. silver in 1941; 1.5 million yds. sand and gravel yielded 1,555 oz. gold, 166 oz. silver in 1943.	On W bank of Sacramento River at Redding. Gold was recovered in jigs as by-product from sand and gravel processed for concrete aggregate for Shasta Dam. For further description, see Columbia Construction Co in tabulated list under sand and gravel, and Redding Sand and Gravel Co. in section on sand and gravel, herein. (Averill 46:283.)
	Consolidated Gold Dredging Company	Sec. 20, 28, T 32 N, R 5 W, MDB&M		Pay gravel 8–20 ft. thick on hard, tilted slate bedrock.	Bucket-line dredge processed 50,000 yds. gravel monthly along Sacramento River near Keswick in 1913. Dismantled. (Brown 16:783.)
92	Crow Creek Dredging Company	Sec. 33, T 30 N, R 6 W, MDB&M	Fred Anderson, Thomas H. Turbush, Clair A. Hill, Box 558, Redding	220,000 yds. from 3–15 ft. gravel between soft shale bedrock and 2–6 ft. overburden on Crow Creek were washed; 100,000 yds. gravel from Cottonwood Creek yielded 580 oz. gold, 20 oz. silver.	About 7 mi. S of Igo. Dragline dredge operated on Crow Creek in 1940–41, and on Cottonwood Creek January 1 to April 13, 1942. Dismantled. (Averill 46:283–284.)
	De Karr and Herbert dredge	Sec. 35, T 33 N, R 5 W, MDB&M	Gene Blake, Summit City	23,800 yds gravel yielded 297 oz. gold, 46 oz. silver.	About 1 mi. S of Central Valley. Dragline dredge operated on Churn Creek from January 16 to March 17, 1941. Dismantled. (Averill 46:284.)
	Detroit and California Mining Company	Sec. 36, T 31 N, R 6 W, & Sec. 31, T 31 N, R 5 W, MDB&M		20 ft. of loose, clean gravel with few boulders, on false bedrock. Gold is coarse, well worn, nearly 950 fine. Gravel yielded $0.25–$1.50/yd. in gold in 1905, with a little platinum.	Operated suction dredge with capacity of 5,000 yds. per 24 hrs. on Clear Creek about 1 mi. downstream from Redding Bar, 1900–02. Disbanded. Property later worked by Shasta Dredging Co., which see. (Doolittle 08:100; Brown 16:798.)
	Diestelhorst dredge	T 32 N, R 5 W, MDB&M		Gravel 7 ft. thick	Dredge anchored in Sacramento River near Middle Creek dug gravel with small scoop shovel operated by steam engine; gravel was screened and washed in sluices. Dredge moved to Clear Creek, operated successfully for several years in 1900s. Dismantled. (Crawford 96:354–355; Diller 04:170; Aubury 10:218.)
	Diving Bell mine	Sec. 26, T 32 N, R 5 W, MDB&M	Undetermined	Gravel up to 12 ft. thick on hard, irregular bedrock.	On Sacramento River just NW of Redding. Clam shell used in 1932 to remove gravel from river bottom, to enable diver to clean bedrock by hand. (Averill 33:60–61.)

GOLD—PLACER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Dixon and Cooper (Channel Placers, Chapman and Voluntines)	Sec. 25, 36, T 31 N, R 6 W, & Sec. 31, T 31 N, R 5 W, MDB&M	Undetermined	Channel trends N in soft granitic bedrock. Pay gravel 20 ft. thick. Quartz-stringer zone about 4 ft. wide in quartz-hornblende diorite with pyrite in seams is undeveloped.	About 1 mi. SW of Centerville. 100 acres patented 1874. Worked as drift and later as hydraulic mine, good producer until 1901. Idle (Brown 16:782.)
	Dobbin Gulch Dredging Company	T 31 N, R 5 W, & T 30 N, R 7 W, MDB&M	James L. Montgomery, Igo Road, Redding	Flat Creek operation involved 142,160 yds. gravel that yielded 853 oz. gold, 62 oz. silver. At Roaring River 70,-500 yds. gravel yielded 169 oz. gold, 11 oz. silver.	Dragline dredge operated on Flat Creek 4 mi. SW of Redding from January to June 1941 and on Roaring River from March 3 to June 2, 1942. Disbanded. (Averill 46:284.)
	Doeblein	Sec. 35, T 31 N, R 6 W, MDB&M	Undetermined	12–25 ft. of tight, clayey gravel with coarse, scaly, rusty gold scattered throughout. Conglomerate bedrock; rims 1,500 ft. apart.	Hydraulic mine 2 mi. E of Igo. Long idle. (Crawford 94:247, 96:355.)
	Enterprise Engineering Company	Sec. 11, T 33 N, R 7 W, MDB&M			About 2½ mi. N of French Gulch. Operated dragline dredge on Clear Creek for a few months in 1946. Dredge was sold and moved to Redding Creek in Trinity County. Disbanded.
93	French Gulch Dredging Company	Sec. 11, 14, T 33 N, R 7 W, MDB&M	French Gulch Dredging Company, 2404 Russ Building, San Francisco (1950)		(Averill 46:284; herein.)
	G & H Mining Company	Sec. 14(?), T 33 N, R 7 W, MDB&M		60,000 yds. gravel yielded 107 oz. gold, 13 oz. silver.	On Cline Gulch about 1 mi. N of French Gulch. Small dragline dredge operated from September 1 to October 22, 1946. Disbanded.
	Gardella dredge	Sec. 36, T 31 N, R 6 W, MDB&M		Fine- to medium-sized gravel 12–22 ft. deep, about ¼ mi. wide; a few feet of soil overburden locally. Gold and 3½ oz. platinum recovered in 1917.	Dredge operated on Clear Creek at Horsetown 1917 and 1926. Dismantled (Logan 18:38; 26:188; 33:61.)
	Gas Point dredge (Savage and Dodson)	Sec. 3, T 29 N, R 6 W, MDB&M		8–12 ft. of gravel above 2-ft. layer of volcanic material beneath which is additional gravel that was not dredged. Gold and platinum recovered.	Bucket-line dredge operated on Cottonwood Creek about 15 mi. W of Cottonwood in early 1930s. Some production. Dredge dismantled by 1938. (Averill 33:61; 38a:122.)
	Gold Acres Dredging Company	Sec. 2, 3, T 29 N, R 6 W, MDB&M		6–12 ft. of gravel over volcanic tuff bedrock; may be a river terrace deposit.	Operated dragline dredge along Cottonwood Creek near Gas Point a few months in 1938. Diaphragm jigs were used instead of riffle tables. Dismantled. (Averill 38a:115–116; 39:135–137.)
	Gold Bar Placers	Sec. 36, T 31 N, R 6 W, MDB&M	Undetermined	Similar to that encountered by Gardella dredge, which see.	On Clear Creek about 6 mi. W of Highway 99. Under option for dredging in 1926. Idle. (Logan 26:188.)
	Gold Nugget Group	Sec. 28, T 31 N, R 6 W, MDB&M	L. S. Freed, Redding		1 mi. N of Igo. Small-scale operation on 4 claims.
	Gold Nugget Placer	Sec. 26, T 33 N, R 5 W, MDB&M	George W. Thorne; address unknown		Near Summit City. Ground sluicing on small scale when water available.
	Griffith dragline	Sec. 16, T 31 N, R 5 W, MDB&M	A. E. Donald, Shasta		About 4 mi. SW of Redding. Small dragline dredge operated on Olney Creek a few months in 1942.
	Grubstake	Sec. 22, T 36 N, R 5 W, MDB&M	Undetermined	Sloping gravel terrace 1–46 ft. thick on slate contains paystreak 40 ft. wide, 30 in. thick. Terrace up to 40 ft. above river level, consists of uncemented, bouldery gravel. Slate has many holes, crevices.	About 2 mi. N of Delta. Located 1917. Gravel was moved by chute to river level, then sluiced. Idle. (Laizure 21:525; Logan 26:186.)
	Gruwell dredge	T 31 N, R 6 W, MDB&M			Dragline dredge was operated in Igo district during 1941. Dismantled. (Averill 46:284.)
	Gypsy King group	Sec. 30, 32, T 31 N, R 5 W, MDB&M	Leone Conant, Redding		In Horsetown district about 5 mi. W of Highway 99. Intermittent small-scale placer mining.
	Hammer (Potts)	Sec. 7, T 32 N, R 6 W, MDB&M	J. J. Hammer, Whiskeytown		Small suction dredge operated on Clear Creek about 2 mi. NW of Whiskeytown for short time in 1947. Overburden removed by bulldozer. Idle. (O'Brien 48:358.)
94	Hardscrabble (Piety Hill)	Sec. 27, 34, 35, 36, T 31 N, R 6 W, MDB&M	Happy Valley Land and Water Company, Olinda	Gravel of Red Bluff Fm. up to 50 ft. thick on bedrock of slate and granitic rock. May represent old terrace of Clear Creek. Gravel averages 20 ft. thick, contains abundant boulders and cobbles, and carries fine gold worth $17/oz. in 1894.	About ¾ mi. E of Igo. 1,700 acres, patented. Worked 1860s as hydraulic and drift mine; about 120 acres worked by 1880, when closed by debris laws. Again active as drift mine for a few years beginning around 1895. Workings consist of hydraulic pit, 1,500-ft. drift tunnel, several 50-ft. shafts. Producer. (Crawford 94:249–250; 96:359; Brown 16:789; Logan 26:186; Averill 39:139; Kinkel et al. 56:42.)
	Huron Submarine Mining and Construction Company	Sec. 25, T 32 N, R 5 W, MDB&M		"Blue" gravel 8–25 ft. thick, with many boulders, on very rough bedrock. Coarse, well worn gold was worth $19/oz. in 1904.	Worked gravel of Sacramento River in early 1900s at Middle Creek, near site of earlier Diestelhorst operation, which see. Diver working in caisson attached to center of dredge moved gravel with high-pressure water hose into 10-in. suction pipe. Capacity was 1,500 yds./day. (Doolittle 08:99–101.)

GOLD—PLACER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Igo Mining Corporation				See Russell, herein.
	Igo Placer Mining Company				Disbanded. See Russell, herein.
	Indian Girl				See White Girl and Indian Girl.
	Jackson, A. J.	Sec. 22, T 32 N, R 5 W, MDB&M			Operated small dragline dredge near Buckeye for about 4 months in 1950.
	Last Chance No. 1 & 2 (Bull Pine and White Horse)	Sec. 30, T 31 N, R 5 W, MDB&M	F. W., F. W. Jr., and F. T. Gerlinger, Redding		About 2½ mi. W of Igo in Centerville district. 4 claims.
	Lava Bed	Sec. 15, T 31 N, R 5 W, MDB&M	Undetermined		About 5 mi. SW of Redding, in Oregon Gulch. Drift mine. Long idle. (Crawford 94:251.)
95	Lincoln Gold Dredging Company	Sec. 34, T 33 N, R 7 W, MDB&M	E. M. Clark, Box 11, French Gulch, and Walter Jansen, Box D, Lincoln		(Averill 46:284; O'Brien 48:358–359; herein.)
	Lost Channel				See Russell, herein.
	Lucky Spot	Sec. 9, T 33 N, R 2 W, MDB&M	Undetermined	Buried channel with up to 100 ft. overburden. Coarse gold up to 4-oz. nuggets associated with sticky, white clay.	About 1½ mi. W of Ingot. 160 acres, patented. 700-ft. incline passes through a hill. Gold difficult to wash. Idle. (Averill 33:67.)
	Metallic Extraction and Engineering Company	Sec. 12, T 29 N, R 4 W, MDB&M			Experimental plant at Cottonwood treated blacksand concentrate rejected by dredges. Table concentrate was dried, heated, and passed through molten lead to make gravity separation of gold and platinum. Several runs of a few tons each were made. Dismantled. (Averill 39:142.)
	Mickey No. 1 & 2	Sec. 28, T 34 N, R 3 W, MDB&M	United States Government		20-in. centrifugal pump used in ground-sluicing operation in May 1941. Inundated by Shasta Lake.
	Midland Company	Sec. 4, T 29 N, R 5 W, MDB&M		Gravel was several hundred feet wide, 7½ ft. deep.	Operated dragline dredge on 2 mi. of Dry Creek above junction with Cottonwood Creek, prior to January 1938. Dismantled. (Averill 38a: 118–119.)
	Myrtle Placer group	Sec. 2, T 32 N, R 5 W, MDB&M	Hugh Williamson, Buckeye Rt., Redding		5 mi. N of Redding, in Buckeye district. 5 claims. Partly dredged. Idle.
	Oak Bottom dredge	Sec. 7, T 32 N, R 6 W, MDB&M	August W. Pipenstack et al., Redding	Gravel 12 ft. deep above hard greenstone bedrock.	2 mi. NW of Whiskeytown. Dragline with dry land washing plant operated on Clear Creek for short period in 1946. Idle.
	Olson dredge	Sec. 19, T 32 N, R 5 W; Sec. 3, T 29 N, R 6 W; Sec. 2, 9, T 32 N, R 5 W, & Sec. 4, T 30 N, R 4 W, MDB&M	Roy S. Olson, Redding		Small dragline and Bodinson washing plant operated in various locations 1937–41 and 1947–57. In 1937, plant washed 3,000 yds. gravel at China Gulch each 18-hr. day. Sluices totaled 640 sq. ft. Dragline and plant cost $43,600, and operating cost was 9 cents/yd. N of Buckeye, 700 yds gravel were washed each 10-hr. day. (Gardner and Allsman 38; O'Brien 51:370.)
	Original	Sec. 11, 13, 14, T 30 N, R 6 W, MDB&M	Undetermined	Cemented sand and gravel	½ mi. W of Centerville. Drift prospect with short circular shaft. (Crawford 94:254.)
	Piety Hill				See Hardscrabble.
	Pilot Dredging Company	Sec. 5, T 30 N, R 5 W, MDB&M			Operated dragline dredge SW of Redding at head of China Gulch during part of 1938. Disbanded. (Averill 39:148–149.)
	Pioneer Dredging Company	Sec. 2, 18, 19, 29, 30, 32, 33, T 32 N, R 5 W, MDB&M			Operated dragline dredge one season at Buckeye in 1936, then 3 dragline dredges on Dry Creek near Igo and Olinda in 1938; one dredge continued active to mid-1941. Dismantled. (Averill 38a:119–120; 46:284.)
	Potts				See Hammer.
	Princess	Sec. 25, 26, T 31 N, R 6 W, MDB&M	Undetermined	30 ft. of gravel on granitic bedrock in NE-trending channel.	Hydraulic and drift mine 2 mi. E of Igo. 600-ft. tunnel on bedrock, drifts, and 50-ft. shafts. Water obtained by 12-mi. ditch from Boulder Creek. Idle since 1901. (Brown 16:797.)
	Prospect Placer	Sec. 12, T 32 N, R 5 W, MDB&M	F. A. Johnson et al., Buckeye	Shallow gravel	Small-scale placer operation N of Redding, near Buckeye.
	Red Hill	Sec. 1, T 30 N, R 7 W, MDB&M	Undetermined	60 ft. of gravel overlain by sandstone averages 60% boulders and cobbles on granitic bedrock that pitches 35° SW. Gravel well cemented near bedrock, with individual cobbles being offset by minor faulting. Flat scale gold, worth $17.50/oz. in 1893, occurs throughout but is richest for 10 ft. above bedrock.	½ mi. NE of Ono. Active 1890s. Gravel worked by blasting, washing with 4-in. monitor. Idle. (Crawford 94:255; 96:357.)
	Roaring River	Sec. 4, 5, T 29 N, R 6 W, MDB&M		Gravel averages 10 ft. deep, 800 ft. wide for 2 mi. along stream. Ratio of gold to platinum-group metals is 20 or 30 to 1.	13 mi. W of Cottonwood. Bucket-line dredge worked up to 2,700 yds. gravel daily on Roaring River in 1938. Dismantled. (Averill 38a:120–122.)

GOLD—PLACER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Roaring River dredge	Sec. 6, T 29 N, R 6 W; Sec. 1, 2, T 29 N, R 7 W; & Sec. 34, 35, T 30 N, R 7 W, MDB&M		Gravel 6–15 ft. deep	A Northwest dragline and floating Bodinson washing plant operated on Roaring River 15–17 mi. W of Cottonwood in 1941. 2,000 yds. worked each 24 hrs. Dismantled.
96	Russell (Blue Bird, Igo Mining Corporation, Igo Placer Mining Company, Lost Channel, Western Contracting Company)	Sec. 34, T 31 N, R 6 W, MDB&M	Ione Crews and Harold Statton, 1731 Pine St., Martinez		(Crawford 94:246; Brown 16:791; Tucker 22:599; Logan 26:186–187; Averill 33:70; 34:305; 39: 150–152; herein.)
	Sacramento Pliocene	Sec. 15, T 31 N, R 5 W, MDB&M	Undetermined	2 ft. of dark, tight, bouldery gravel on slate bedrock; overlain by 70 ft. of sandstone. Gold on and in bedrock.	In Oregon Gulch 5 mi. SW of Redding. Drift mine with 42-ft. shaft and drift 125 ft. E at bottom. Idle since 1895. (Crawford 94:256; 96:364.)
	San Gruco Company	Sec. 34, T 31 N, R 6 W, MDB&M			Operated dragline dredge on Dry Creek about 1 mi. S of Igo in summer of 1940; moved to land of Happy Valley Water Company in November, and operated into 1941. Dismantled. (Averill 46:285.)
	Savage and Dodson dredge				See Gas Point dredge.
	Schuyler	Sec. 27, T 31 N, R 6 W, MDB&M	Undetermined	Bedrock pitches SE	Drift and hydraulic mine ¾ mi. from Igo. Worked by Chinese company in 1893. Tunnel 1900 ft. long with 280-ft. incline at 1500 ft. Breasts 30 to 100 ft. wide, 6 ft. high. 3 air shafts 48–66 ft. deep. Hydraulic mine on same claim had bank 55 ft. high. Long idle. (Crawford 94:256–257.)
	Scott				See Tripp.
	Shasta Dredging Company	Sec. 31, 32, T 31 N, R 5 W, & T 30 N, R 6 W, MDB&M		Gravel on Clear Creek 20–40 ft. thick on locally-soft, tilted, slate bedrock. Gravel loose, medium-sized, had few boulders and little clay. Gravel averaged 6–25 cents/yd. in coarse gold, valued at $19/oz. in 1909. At Gas Point, some platinum-group metals were recovered with gold in 1917; proportions were: platinum 33%, iridium 50%, osmiridium 17%.	Acquired 400 acres on Clear Creek in Horsetown district in 1902, after Detroit and California operation, which see, failed. Began work with bucket-line dredge, which burned shortly after. Second dredge began operating 1906, worked at rate of 60,000 yds./month. 100 acres dredged by 1913. In 1917, began working on Cottonwood Creek near Gas Point; continued here to end of 1923. In 1922, acquired interest in ground near Minersville, Trinity County. Disbanded. (Diller 04:170–171; Auburn 10:215–217; Brown 16:798; Logan 18: 38; Tucker 22:6, 207, 297; Logan 24:15.)
	Sholes, Earl	Sec. 21, T 31 N, R 5 W, MDB&M	Undetermined		Operated dragline dredge on Tadpole Creek 5 mi. SW of Redding for short time in 1946.
	Slattery and Welch	Sec. 8, T 33 N, R 6 W, MDB&M	Undetermined	Coarse gold in pay streak 5–10 ft. thick. Channel trends SW.	Hydraulic mine about 5 mi. NE of French Gulch. Small producer. Idle. (Brown 16:798–799.)
	Tehama Dredging Company	Sec. 2, T 29 N, R 6 W, MDB&M	R. W. and T. A. Dailey; address unknown	12 ft. of gravel on volcanic ash bedrock; 48,860 yds. yielded 242 oz. gold, 17 oz. silver.	Operated dragline dredge on Gold Acres tract, which see, 12 mi. W of Cottonwood for 3 months in 1941. (Averill 46:285.)
97	Thurman Gold Dredging Company	Sec. 26, 27, T 31 N, R 5 W, MDB&M	Thurman and Wright, 625 Market Street, San Francisco		(Averill 46:285; O'Brien 48:360; 51:371; herein.)
98	Tripp (Scott)	Sec. 2, T 32 N, R 7 W, MDB&M	Chas. Tripp et al., Redding; leased to James I. Scott of Santa Rosa (1950)	Terrace gravel above Clear Creek.	About 1 mi. SE of Tower House. Mined with bulldozer in 1950; sand screened by trommel, gold recovered in sluice boxes. Operation was short lived.
	Vergnes	Sec. 7, 17, T 32 N, R 6 W, MDB&M	Chester and Henry Vergnes, Oak Bottom		On Clear Creek 1 mi. NW of Whiskeytown. Intermittent small-scale mining in 1932. Idle. (Averill 33:72–73.)
	Western Contracting Company				See Russell, herein.
	White Girl and Indian Girl	Sec. 9, T 31 N, R 5 W, MDB&M	Halie Feslich; address unknown		3 mi. SW of Redding. 2 patented claims. Idle. (Averill 39:159.)
	White King	Sec. 9, T 31 N, R 5 W, MDB&M	R. L. Effenbeck et al., Igo Road, Redding		2½ mi. SW of Redding. 2 claims.
	Wyandotte Gold Dredging Company	Sec. 17, T 31 N, R 4 W, MDB&M			Bodinson floating washing plant and electric power shovel operated on Churn Creek near Enterprise for short time. Plant sold to Carlson and Sandburg, which see, prior to 1937 and moved to Clear Creek. (Averill 38a:123.)

IRON

	Bass				See Shasta Iron group, herein.
	Black Diamond	Sec. 2, 3, T 33 N, R 4 W, MDB&M	Jesse L. Brown, et al., Redding	Small masses magnetite in contact-metamorphic environment.	Near Gray Rocks, 5 mi. N of Project City. For additional geology, description, and references see in copper section.
	Black Diamond 1 & 2	Sec. 8, T 35 N, R 3 W, MDB&M	Undetermined	Coarse magnetite float covers area of 150 by 400 ft.; some magnetite dump material.	On E slope Hirz Mountain. Several shallow pits. Idle.

IRON—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	California Consolidated Mines group	Sec. 26, T 34 N, R 4 W, MDB&M	Nellie F. Bass, et al., c/o Chenoweth and Leininger, Attys., 1525 Pine St., Redding	.....	NE of junction Pit and McCloud Rivers. Located probably in early 1900s. Leased and operated with Shasta Iron group during World War II. For geology and description of this later work, see Shasta Iron group, herein. Idle. (Aubury 06:301–303; Logan 26:190.)
	Deep Pit group	.....	.....	.....	See Peterson group.
	G.I.D. group	Sec. 25, 26, T 34 N, R 4 W, & Sec. 30, T 34 N, R 3 W, MDB&M	G. I. Dumond, et al., 1230 44th Street, Sacramento	.....	E of junction Pit and McCloud Rivers, E of Shasta Iron group. 78 claims located in August 1954. Undeveloped.
99	Hirz Mountain (Jennings group)	Sec. 7, 8, T 35 N, R 3 W, MDB&M	Southern Pacific Land Company et al, 65 Market St., San Francisco	.....	(Diller 04:178; 06:14; Aubury 06:304; Logan 26:190; Averill 39:161; Lamey 48; herein.)
100	Iron Mountain	Sec. 34, T 33 N, R 6 W, MDB&M	Mountain Copper Company of California, 100 Mococo Rd., Martinez	.....	Herein. For regional geology and description of other operations, see sections on copper, gold, and pyrite, herein. For extended list of references see tabulated list under copper. (Kinkel et al., 56:119; herein.)
	Jennings group	.....	.....	.....	See Hirz Mountain.
	Lost Confidence Company	Sec. 34, 35, T 33 N, R 6 W, MDB&M	Mountain Copper Company of California, 100 Mococo Rd., Martinez	Deposit of hematite	6 mi. NW of Shasta, near Slickrock Creek. Probably associated with deposits of magnetite known to occur on Mountain Copper Co. property; see Iron Mountain, herein. (Crawford 94:327.)
	Maxwell	Sec. 26(?), T 34 N, R 4 W, MDB&M	Undetermined	Magnetite in limestone	1¾ mi. E of Baird Fishery site. May be same as Maxwell claim that forms part of California Consolidated Iron group, which see. (Crawford 94:327.)
	Noble Electric Steel Company	.....	.....	.....	At Heroult, 2½ mi. E of junction Pit and McCloud Rivers. Electric-arc smelter built 1907; produced pig iron to 1914, then ferromanganese and ferrosilicon until end of World War I. Idle since. Site inundated by Shasta Lake. Smelter charged with charcoal, barren quartz, limestone, and iron ore to make various grades of iron with very low sulfur and phosphorous, and 1–5% silica. Iron ore used during World War contained 68% Fe, 1–2% SiO_2; it came from Shasta Iron group, which see herein. See also Pit River Consolidated, in manganese section. (Brown 16:805–806; Logan 26:190–191; Averill 39:161.)
	Peterson group (Deep Pit group)	Sec. 36, T 34 N, R 4 W, MDB&M	United States Government	Gossan 500 ft. wide, 1 mi. long; trends N. Some pyrite, copper minerals in adits.	On S side Pit River about 2 mi. E of Gray Rocks. Several short adits. Undeveloped. May be same as Wood property, which see. (Logan 26:192.)
	Potter	T 34 N, R 4 W, MDB&M	Undetermined	Magnetite with some limonite in limestone.	1½ mi. E of U.S. Fishery site on McCloud River. Idle. (Crawford 94:327.)
	Roseman	Sec. 3, T 33 N, R 4 W, MDB&M	Undetermined	Some magnetite and locally chalcopyrite at contact between McCloud Limestone and augite quartz diorite dike.	On W side of Gray Rocks, about 12 mi. NE of Redding. Active around 1902–05. Cuts and short adits. Long idle. (Diller 03:130; Aubury 06:303.)
101	Shasta Iron Company group	Sec. 26, T 34 N, R 4 W, MDB&M	Shasta Iron Company, c/o Bunker Hill Iron Exploration, 620 Market St., San Francisco 4	.....	(Crawford 94:327; Diller 03:130–131; 03a; 04:178; 06:14; Aubury 06:301–303; Prescott 08:471–472; Brown 16:805–806; Logan 26:192; Averill 39:161–162; O'Brien 43:82, 327; U.S. Bur. Mines 43; Lamey, 48a; O'Brien 48:360–361; Shattuck and Ricker 48; Stephens and Morning 49; Lamey 61; herein.)
	Wood	Sec. 1, T 33 N, R 4 W, MDB&M	Rodney Wood, et al., P.O. Box 1192, Redding	Metavolcanic rock partially replaced by spongey red hematite in N-to NW-trending zone 40–450 ft. wide, about ½ mi. long. Samples reported to assay 35–40% iron. Extension of gossan on former Pit River Consolidated claims, which see under manganese.	Near Cove Creek, 1¾ mi. E of Gray Rocks and 12 mi. NE of Redding. Located mid-1960, sampled by Bunker Hill Co. late 1960. Shallow pits and cuts. No production.

LEAD

	Afterthought	Sec. 10, 11, 15, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Co., 1206 Pacific Mutual Building, Los Angeles 4	Since 1905, has yielded more than 3,170 tons lead.	For description of mine and geology, see copper section, herein. (Albers 53:5.)
	Asher (Calcopirate, Jacksonian)	Sec. 2, T 33 N, R 2 W, MDB&M	James G. Asher and George S. Burns, Redding	Ore contains galena and sphalerite.	Near highway, about 1½ mi. NE of Ingot. Inclined shaft 60 ft. deep. Idle. (Logan 26:192; Averill 39:162.)
	Bell	Sec. 21, T 34 N, R 1 W, MDB&M	I. A. Dunlap and Joseph Buchea, Redding	.....	2 mi. SW of Round Mountain. Short adit, winze, and shallow cuts. Prospect. Idle.
	Calcopirate	.....	.....	.....	See Asher.
	Cartwright	.....	.....	.....	See Highgrade.

LEAD—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Climax	Sec. 16, T 31 N, R 6 W, MDB&M	Grace J. Marton; address unknown	In 1920s, ore shipment of 4,210 lbs. assayed 6.6% lead.	3 mi. N of Igo. Idle. For geology and additional description, see in section on silver. (Goodwin 57:688.)
	Davidson	T 33 N, R 2 W, MDB&M.	Undetermined	Shipped ore yielded 6.8% lead.	Made small shipment highgrade gold-silver ore 1913; smelter recovered 6.8% lead. (Goodwin 57:688.)
	Donkey	Sec. 11, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Company, 1206 Pacific Mutual Bldg., Los Angeles	Ore shipped 1913 averaged 5.20% lead.	Near Afterthought mine. For geology and description, see section on copper. (Goodwin 57:689.)
	Highgrade (Cartwright)	Sec. 27, T 34 N, R 1 W, MDB&M	Mrs. Frances B. Hamilton, San Jose	Small lenses ore contain high percentage galena and sphalerite. Smelter recovery averaged 5.67% lead, 23.50 oz./ton silver, 0.114 oz./ton gold.	About 2 mi. S of Round Mountain. Ore shipped 1926. 2 adits about 80 ft. long; old inclined shaft. Idle. (Logan 26:193; Averill 39:162; Goodwin 57:690.)
	Ingot Mining Company	Sec. 1, T 33 N, R 2 W, MDB&M	Joseph Shafter and Robert Allsop, Shasta	Lead-zinc ore consists mostly of fragmentary material in landslide debris.	About 2 mi. NE of Ingot. Inclined shaft 135 ft. deep with 20-ft. crosscut on 85-ft. level. A little highgrade material collected in 1952. Idle.
	Iron Mountain	Sec. 26, 27, 33, 34, 35, 36, T 33 N, R 6 W, MDB&M	The Mountain Copper Company, 100 Mococo Road, Martinez	Total lead production about 150,000 lbs.	For regional geology and description of operations see sections herein on copper, gold, pyrite, and iron. For extended list of references see tabulated list under copper. (Goodwin 57:691.)
	Jacksonian	.....	.....	.....	See Asher.
	Jones	Sec. 5, 6, T 30 N, R 6 W, MDB&M	Stanley J. and Sydnie Jones, Igo	Outcrops contain galena and sphalerite.	2 mi. E of Ono. Some surface prospecting. Idle. (Averill 39:162.)
	Mammoth	Sec. 32, T 34 N, R 5 W, MDB&M	United States Smelting, Refining and Mining Company, 921 Newhouse Building, Salt Lake City, Utah	Large tonnage smelter slag shipped in 1948 yielded 12.42% lead. Large tonnage flue dust shipped from Mammoth smelter in 1951–52 averaged 7.96% lead.	For geology and description of operations, see copper section, herein. (Goodwin 57:692.)
	Old Glory and Highway	Sec. 30, T 34 N, R 1 W, MDB&M	Undetermined	Fissures and seams strike NW in limestone, contain galena and sphalerite.	5½ mi. NE of Ingot. Prospected by shallow openings. Idle. (Logan 26:215–216; Goodwin 57:693.)
102	Silver Fern	Sec. 29, T 34 N, R 1 W, MDB&M	F. L. and W. R. Richter, Bella Vista	Argentiferous galena, sphalerite, and specular hematite occur in zone that dips 15° NE in metavolcanic rock. Zone is 6–8 in. thick, thins laterally in both directions to narrow seam. Small shipment ore in 1948 contained 24.70% zinc, 6.20% lead, 13.53 oz./ton silver, and recoverable copper.	About 5 mi. NE of Ingot. Short inclined drift was filled with water in 1962. (Goodwin 57:695.)
	Sugarloaf and Homestake group	Sec. 4, T 33 N, R 2 W, MDB&M	Mrs. Nora B. Hill, Redding, and Charles Walters, Bella Vista	Quartz and siliceous rock contain pyrite, galena, sphalerite, and chalcopyrite in zone several feet wide at contact between slate and metarhyolite.	On S slope Sugar Loaf Mountain about 1½ mi. W of Ingot. Several long adits, shallow shafts comprise about 1,200 ft. of workings. No production. Assessment work only. (Averill 39:162–163; Goodwin 57:695.)

MANGANESE

	Arps group	Sec. 20, 21, 28, T 34 N, R 3 W, MDB&M	United States Government.	Grade "likely to be low".	1 mi. SW of Bully Hill. See also in copper section. (Trask 50:265.)
	Beegum Creek	.....	.....	.....	See Nicol.
	Duncan Creek	T 30 N, R 8 W, MDB&M.	Undetermined	.....	On Duncan Creek about 8 mi. W of Ono. Undeveloped and idle. (Trask 50:266.)
	Goat Camp	Sec. 36, T 29 N, R 11 W, MDB&M	Undetermined	Rhodonite, bementite, rhodochrosite occur in small mass of chert enclosed by greenstone. Ore grade about 30% Mn, reserves estimated at less than 20 tons.	About 7 mi. SW of Harrison Gulch Ranger Sta. Prospected by 2 shallow pits prior to 1942. (Trask 50:266.)
	Nicol (Beegum Creek)	Sec. 22, T 29 N, R 9 W, MDB&M	Undetermined	Manganese oxide estimated to contain 10–15% manganese occurs in body 5 ft. wide, 50 ft. long, enclosed by vertical, massive chert striking N 85° E.	1 mi. SE of Platina. Worked around World War I. Small cut. Idle. (Trask 50:266.)
103	Nigger Hill	Sec. 14, T 30 N, R 8 W, MDB&M	Earl M. Summers, 1735 Pine Street, Redding	Medium-grained biotite schist includes beds of fine-grained quartzite (metachert?), locally offset by faulting. Ore consists of psilomelane and pyrolusite enclosing patches of quartzitic rock. Minor rhodonite. Manganiferous rock locally is 8 ft. thick.	6½ mi. W of Ono. A few tons sorted ore shipped in 1944. Idle. (Trask 50:266–267.)
	Noble Electric Steel Company	.....	.....	.....	See Pit River Consolidated.

MANGANESE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
104	Pit River Consolidated (Noble Electric Steel Company, Shasta Copper Company)	Sec. 36, T 34 N, R 4 W, & Sec. 1, T 33 N, R 4 W, MDB&M	Rodney Wood, P.O. Box 1192, Redding	Ore occurs in decomposed, sheared porphyritic metarhyolite in contact with slate to E and locally with red jasper on W. Prevailing strike in area is N, prevailing dip E. Ore is soft, consists of intimate mixture of psilomelane, pyrolusite, kaolin, iron oxides, quartz, opal, and chalcedony. An assay of ore prior to 1918 showed 19.77% manganese, 6.72% iron, 0.18% phosphorous, 34.04% silica, and $1.65/ton gold (Morse 1950, p. 269). Logan (1926) reports that ore contained 20–28% manganese, 23–37% silica, 6.7% iron. Gossan contains pyrite, chalcopyrite, and copper oxides; said to contain 10–15% manganese, up to $1.25/ton gold, and several ounces/ton silver. Morse (1950, p. 271) estimated in 1918 that 25,000 tons ore carrying 15–20% manganese were "available".	N of Cove Creek, about 1½ mi. NE of Gray Rocks. Shasta Copper Co. located 38 claims in S ½ Sec. 36 and NE ¼ Sec. 1, now largely inundated by Shasta Lake, to develop copper ore thought to lie beneath prominent gossan. Leased 1916–17 by Noble Electric Steel Co., and 1,000 tons ore mined and used in production of ferromanganese. Mine idle since fall 1917. Several short adits total 200 ft. in length. See also Noble Electric Steel Co. and Wood, in iron section. (Brown 16:807; Bradley 18:80–81; Logan 26:199; Averill 39:166; Morse 50:267–271.)
	Shasta Copper Company				See Pit River Consolidated.
	Victor	T 30 N, R 10 W, MDB&M.	Undetermined	Hard, bluish quartzite (metachert) associated with mica schist contains irregular bunches and fracture fillings of non-commercial manganese oxide.	On S slope Chanchellula Peak. Undeveloped. (Morse 50:271.)

MOLYBDENITE

105	Boulder Creek	Sec. 33, T 37 N, R 5 W, MDB&M	State of California	Thin flakes molybdenite up to 1 mm. long disseminated in aplitic dike that strikes N 65° E, dips 37° S in peridotite. Dike up to 12 ft. wide, traced for 1,200 ft; mineralized portion 700 ft. long. Some pyrite. Ore shipped in 1917 assayed 1.31% MoS_2; that treated in 1918 contained 2.6% MoS_2. Averill (1939, p. 169) reports "numerous" assays of 3.5–3.8% MoS_2.	S of Boulder Creek, about 2 mi. W of Gibson. 100 tons ore shipped to Denver for concentration in 1917. Flotation plant built 1917, operated briefly 1918. Property prospected 1938. 50-ft. vertical shaft with 16-ft. drift at 30 ft. and 10 ft. drift at bottom. Idle. (Boalich and Costello 18:23, 24; Bradley 19:56; Logan 26:200; Averill 39:168–169.)

PLATINUM

	Shasta Platinum Company				Small processing plant built at Shasta in 1944 to recover platinum from black sand concentrates obtained from various placer mining operations on Clear Creek. Concentrates were ground with quicksilver and undisclosed chemicals in 5-ft.-diameter Loraine muller, and heavier particles recovered on a Wilfley table. Active intermittently 1944–46. Dismantled.

PYRITE

	Iron Mountain (Brick Flat, Hornet, Richmond)	Sec. 26, 27, 34, 35, T 33 N, R 6 W, MDB&M	Mountain Copper Company of California, 100 Mococo Rd., Martinez		Herein. For extended list of references see under copper; for additional description see in sections on copper, gold, and iron, herein.

QUICKSILVER

	Clover Creek	Sec. 4, 5, T 32 N, R 1 W, & Sec. 32, T 33 N, R 1 W, MDB&M	R. W. Byers, et al., 2030 California St., Redding	Mineralized zone trends NW in altered metarhyolite, contains sparse cinnabar in thin seams and vugs.	About 5 mi. NW of Whitmore. Located around 1898, active until around 1904. Several shafts, as much as 50 ft. deep, and some adits. No production. Long idle. (Forstner 03:196; Bradley 18:168.)

SILVER

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Afterthought	Sec. 10, 11, 15, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Co., 1206 Pacific Mutual Building, Los Angeles 4	Has yielded about 923,650 oz. silver.	For description and geology, see copper section herein; for list of references, see tabulated list under copper. (Albers and Robertson 61:81.)
	Balaklala	Sec. 11, 12, 13, 14, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	Total silver production estimated at 1,200,000 oz.	For description and geology, see copper section herein; for list of references, see tabulated list under copper. (Kinkel et al. 56:103.)
106	Big Dyke (Igo Mining Company)	Sec. 18, 19, T 31 N, R 6 W, MDB&M	C. H. and Frank Richter, Box 1250, Cottonwood Ave., Redding	.....	(Laizure 21:526–527; Tucker 22a:317–318; Logan 26:204–205; Averill 39:171; Goodwin 57:686; Albers 65:31; herein.)
	Bully Hill and Rising Star	Sec. 15, 16, 21, 22, 28, T 34 N, R 3 W, MDB&M	Glidden Company, Union Commerce Bldg., Cleveland, Ohio	Total silver production about 2,215,270 oz.	For description and geology, see copper section herein; for list of references, see tabulated list under copper. (Albers and Robertson 61:90.)
	Chicago Consolidated	.....	.....	.....	See Silver Falls-Chicago Consolidated, herein.
107	Climax	Sec. 16, 21, T 31 N, R 6 W, MDB&M	G. A. and Mary Broderick, 2620 California St., Huntington Park	Vein about 10 ft. wide at contact between greenstone and quartz diorite strikes N 10° E, dips 50° E. Second vein 80 ft. W is parallel in quartz diorite. Undeveloped vein system 200 ft. farther W strikes N 20°–40° E, dips 70°–80° E. Lenticular orebody 50 ft. long, 1–2 ft. wide in second vein was stoped from Climax shaft. Veins carry native silver, tetrahedrite, sphalerite, chalcopyrite, pyrite, and gold. Ore taken from Black Prince shaft said to average $10/ton in gold and silver. 4,210 lbs. ore taken from Climax shaft in 1922 assayed 0.08 oz. gold, 214.9 oz. silver, 6.6% lead, and 25.2% zinc.	About 2 mi. NW of Igo. Some development and small production prior to 1913; active into 1920s. Small production from Climax shaft in 1922. Climax shaft is 150 ft. deep with short drifts N and S at 100-ft. level and 75 ft. E at bottom. Inclined shaft 150 ft. to S is 75 ft. deep, is stoped to surface for 100 ft. N and S of shaft. Other workings include 110-ft. Black Prince shaft with crosscut E at 100-ft. level, and 33-ft. shaft on South Climax claim. All workings except Climax shaft are on main contact vein. Idle. (Brown 16:782; Tucker 22a:320; Logan 26:205–206; Albers 65:31–32.)
	Continental (Mabel C.)	Sec. 7, 18, T 31 N, R 6 W, MDB&M	V. V. Apperson, Willows.	Vein 8 in. to 3 ft. wide in quartz diorite strikes N 45° E, dips 80° SE; second vein strikes N 10° E. NE vein contains argentiferous galena, native silver, tetrahedrite, sphalerite, pyrite, and a small amount of gold in quartz and altered quartz diorite. Ore is oxidized to depth of 20–50 ft.	4 mi. NW of Igo. Producer in 1880s. Some work in later years. Crosscut adit with 200-ft. drift, and 200-ft. upper adit, on NE vein. N vein undeveloped. Ore treated in 6-stamp mill. Long idle. (Tucker 22a:320; Logan 26:206; Albers 65:32.)
	Crystal	.....	.....	.....	See White Star.
	Donkey	Sec. 11, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Company, 1206 Pacific Mutual Bldg., Los Angeles	Ore shipped 1913 contained 17.62 oz./ton in silver.	For geology and description, see in copper section (Goodwin 57:689.)
	Early Bird	Sec. 10, 11, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	Has yielded about 72,098 oz. silver.	For description and geology, see copper section herein; for list of references, see tabulated list under copper. (Kinkel et al. 56:112.)
	Golinsky	Sec. 28, T 34 N, R 5 W, MDB&M	United States Government.	Total silver production about 25,313 oz.	For description and geology, see copper section herein; for list of references, see tabulated list under copper. (Kinkel et al. 56:114.)
	Highgrade	Sec. 27, T 34 N, R 1 W, MDB&M	Mrs. Frances B. Hamilton, San Jose	Ore shipped 1926 yielded 23.50 oz./ton in silver.	See also in lead section (Goodwin 57:690.)
	Igo Mining Company	.....	.....	.....	See Big Dyke, herein, and White Star, herein.
	Iron Mountain	Sec. 26, 27, 33, 34, 35, 36, T 33 N, R 6 W, MDB&M	The Mountain Copper Company, 100 Mococo Road, Martinez	Total silver production estimated at 26,558,780 oz.	For description and geology, see herein under copper, gold, iron, and pyrite; for extended list of references, see in tabulated list under copper. (Kinkel et al. 56:118.)
	Mabel C.	.....	.....	.....	See Continental.
	Mammoth	Sec. 32, T 34 N, R 5 W, MDB&M	United States Smelting, Refining and Mining Company, 921 Newhouse Bldg., Salt Lake City, Utah	Has yielded about 7,416,965 oz. silver.	For description and geology, see copper section herein; for list of references, see tabulated list under copper. (Kinkel et al. 56:133.)
	Shasta King	Sec. 11, 12, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	Known silver production is about 69,578 oz.; 15,000 tons of ore of unspecified grade produced 1908–09 presumably contained some silver.	For description and geology, see copper section herein; for list of references, see tabulated list under copper. (Kinkel et al. 56:140.)
108	Silver Falls-Chicago Consolidated	Sec. 17, 18, 19, 20, T 31 N, R 6 W, MDB&M	Bertha F. Johnstone, et al., Redding; Claud Harris, 2198 Court St., Redding, lessee	.....	(Brown 16:798; Laizure 21:527–528; Tucker 22a:313–314, 316–317; Logan 26:207–210; Averill 39:171–172; Kinkel et al. 56:59; Albers 65:31, 32; herein.)
	Silver Fern	.....	.....	.....	See in section on lead.

SILVER—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
109	Silver King	Sec. 8, T 31 N, R 5 W, MDB&M	Ed Jaensch, P.O. Box 1624, Redding; Claud Harris, 2198 Court St., Redding, lessee	Brecciated quartz vein at footwall of dike in Copley Greenstone strikes N, dips 82° E; dike is 65 ft. wide, vein averages 2 ft. with maximum thickness of 8 ft. Ore is principally chalcopyrite, chalcocite, and argentite; other ore minerals present are tetrahedrite, pyrite, galena, and some gold. Unsigned record of shipments to Mammoth Copper Mining Co. smelter at Kennett indicates that 70 tons ore in 1912 yielded about 5,420 oz. silver and 3,370 lbs. copper, and 120 tons in 1913 yielded about 7,028 oz. silver and 3,286 lbs. copper. Owner at at this time (L. C. Parker) estimated in 1915 that total production was 450 tons ore yielding about $9,000. Laizure (1912) reports that a stope 40 x 2 x 80 ft. yielded 1,000 tons of "good grade ore" (but if density of rock was 2.6, only 520 tons could have been extracted). Hollister (1949) states that smelter receipts show progressive decrease in values with passing time, and last shipment averaged 17 oz. silver, less than 1% copper.	About 4 mi. SW of Redding. First active around 1885 when steeply inclined shaft sunk 70 ft. Relocated 1904. Production recorded 1912–13 No. 2 shaft 110 ft. N and 100 ft. E of old shaft sunk to depth of 225 ft. in 1914–15. 30-ft. crosscut to vein at depth of 150 ft.; drifts on vein 210 ft. N. and 153 ft. S. Raises 20–55 ft. in ore from N drift 18, 68, and 108 ft. N of crosscut; raises 40 ft. in ore from S drift 35 and 150 ft. S of crosscut. Probable production in 1917. Last active 1918 except for reworking of dump in 1933. No. 2 shaft ultimately reached depth of 325 ft. with levels at 90, 150, 200, and 300 ft. Length of workings on each level are, respectively, 80, 363 (not including raises), 160, and 140 ft. (Fairbanks 93:44; Laizure 21:528; Averill 39:172; Hollister 49; Claud Harris, 1964, personal communication.)
110	White Star (Crystal, Igo Mining Company	Sec. 20, T 31 N, R 6 W, MDB&M	Mrs. M. E. Hawe, Igo		(Brown 16:784; Tucker 22a:319–320; Logan 26:210; Averill 39:172–173; Goodwin 57:696; Albers 65:32; herein.)

TUNGSTEN

	Ajax	Sec. 28, T 33 N, R 6 W, MDB&M	August Herman and Les Ralston, Whiskeytown	Scheelite noted in lower adit.	About 4 mi. N of Whiskeytown. See in gold section, herein.
	Buena Vista	Sec. 5, T 31 N, R 5 W, MDB&M	H. G. Graves, Redding	Scheelite occurs in auriferous quartz vein; grade does not vary vertically.	About 3 mi. W of Redding. No tungsten production. See also in gold section.
	Hope So				See Milton, herein.
	Milton	Sec. 31, 32, T 32 N, R 5 W, MDB&M	Alfred and Ray Leslie, Shasta		See herein, under gold.
	St. Jude	Sec. 17, T 33 N, R 7 W, MDB&M	St. Jude Mining Company, c/o A. P. Robillard, Box 374, Redding	Small amount of scheelite occurs in quartz veins.	See herein, under gold.
	Washington	Sec. 16, 17, T 33 N, R 7 W, MDB&M	J. H. Scott, 11 Corte Encanto, San Rafael	Small amount of scheelite occurs in quartz veins.	See herein, under gold. For extended list of references, see tabulated list under gold.

ZINC

	Afterthought	Sec. 10, 11, 15, T 33 N, R 2 W, MDB&M	Coronado Copper and Zinc Co., 1206 Pacific Mutual Building, Los Angeles 4	Intermittent recovery of zinc 1926–52 totaled about 23,636,000 lbs.	For description and additional references, see under copper, herein. (Albers and Robertson 61:81.)
	Balaklala	Sec. 11, 12, 13, 14, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	Total production of zinc estimated at 31,200,000 lbs.	For description and additional references, see under copper, herein. (Kinkel et al. 56:103.)
	Bully Hill-Rising Star	Sec. 15, 16, 21, 22, 28, T 34 N, R 3 W, MDB&M	Glidden Company, Union Commerce Bldg., Cleveland, Ohio	Total zinc production was 25,113,105 lbs.	For description and additional references, see under copper, herein. (Albers and Robertson 61:90.)
	Climax	Sec. 16, 21, T 31 N, R 6 W, MDB&M	G. A. and Mary Broderick, 2620 California St., Huntington Park	Shipped ore in 1922 containing 25.2% zinc.	See also in silver section. (Goodwin 57:688.)
	Crystal				See White Star.
	Golinsky	Sec. 28, T 34 N, R 5 W, MDB&M	United States Government	3,078 tons ore yielded 549,660 lbs. zinc in 1906–07; 3,198 tons were produced 1935–37 for which zinc content is not recorded.	For description and additional references, see under copper. (Kinkel et al. 56:114.)
	Iron Mountain	Sec. 26, 27, 33, 34, 35, 36, T 33 N, R 6 W, MDB&M	The Mountain Copper Company, 100 Mococo Road, Martinez	1,608,000 tons ore contained an estimated 2–5% zinc (64 million to 161 million lbs.); 380,000 tons additional ore yielded 26,600,000 lbs. zinc.	For geology and description of operations, see herein under copper, gold, iron, and pyrite; for extended list of references, see tabulated list under copper. (Kinkel et al. 56:118.)

ZINC—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Mammoth	Sec. 32, T 34 N, R 5 W, MDB&M	United States Smelting, Refining and Mining Company, 921 Newhouse Bldg., Salt Lake City, Utah	Total production of zinc was about 313,711,000 lbs., including 84,000 tons unsorted ore mined 1914–15 that averaged 21.10% zinc.	For description and additional references, see under copper, herein. (Kinkel et al. 56:133.)
	Shasta King	Sec. 11, 12, T 33 N, R 6 W, MDB&M	Shasta Minerals & Chemical Co., 826 S. Main St., Salt Lake City, Utah	Total zinc production probably was about 14,700,000 lbs.	For description and additional references, see under copper, herein. (Goodwin 57:694.)
	Silver Fern	Sec. 29, T 34 N, R 1 W, MDB&M	F. L. and W. R. Richter, Bella Vista	Small ore shipment in 1948 contained 24.70% zinc.	See also under lead. (Goodwin 57:695.)
	St. John	Sec. 30, T 34 N, R 1 W, MDB&M	Lola Olmstead, Bella Vista	Sphalerite with a little galena and copper sulfide occurs in small ore zone as irregular masses and stringers in gray limestone. Selected samples assayed 19% zinc.	4 mi. SW of Round Mountain. A few tons ore mined prior to 1926. Idle. (Logan 26:216.)
	White Star (Crystal)	Sec. 20, T 31 N, R 6 W, MDB&M	Mrs. M. E. Hawe, Igo	Some ore shipped in 1922 contained 13.3% zinc.	For description and references, see under silver, herein. (Goodwin 57:696–697.)

ASBESTOS

	Anaconda	Sec. 6, T 37 N, R 4 W, MDB&M	United States Government.	7 small veins of tremolite asbestos in serpentine average 2 ft. in width, strike N and dip 50° E.	About 3 mi. NW of Sims. Open cuts. No recorded production. Idle. (Brown 16:755; Logan 26:128.)
	Asbestos Empress	.....	.....	.....	See Blas.
111	Blas group (Asbestos Empress)	Sec. 20, T 37 N, R 5 W, MDB&M	Blas Asbestos Corporation, c/o John Boito, 919 Michigan Avenue, San Jose	.....	(O'Brien 51:369; Wiebelt and Smith 59:24–25; herein.)
	Hanegan	Sec. 12, T 37 N, R 6 W, MDB&M	United States Government.	.....	Chrysotile asbestos fibers ½ in. long occur near Highland Lake. (Averill 39:113.)
	Loma Blanca Mines, Inc.	.....	.....	.....	See Stock.
	Miles	Sec. 36, T 38 N, R 5 W, MDB&M	United States Government.	.....	About 4 mi. NW of Sims. Discovered around 1913. Undeveloped. (Brown 16:755.)
	Powhatan Mining Company	.....	.....	.....	See Stock.
	Powmears	.....	.....	.....	See Sylvester.
112	Stock (Loma Blanca Mines, Inc., Powhatan Mining Company)	Sec. 1, 2, 4, 12, T 37 N, R 5 W, & Sec. 33, T 38 N, R 5 W, MDB&M	Ida M. Boyle et al, 17308 S. Ardmore Ave., Bellflower; leased to Powhatan Mining Company (1954)	.....	(Brown 16:752–755; Tucker 22:296–297; Logan 26:128–129; Averill 39:113; O'Brien 48:355; 51:370; Wiebelt and Smith 59:2, 25; herein.)
113	Sylvester (Powmears)	Sec. 1, T 37 N, R 5 W, MDB&M	Southern Pacific Land Company, San Francisco; leased to Ray J. Sylvester, P.O. Box 604, Redding	.....	(O'Brien 48:355; Wiebelt and Smith 59:2, 26; herein.)

BARITE

114	Afterthought	Sec. 2, T 34 N, R 4 W, MDB&M	United States Government.	Several veins of coarsely crystalline, white barite a few inches to 5 ft. wide in mildly metamorphosed sandstone and similar rocks of Baird Fm., close to contact with fine grained gabbro, which lies to the N. Principal veins strike NE, dip steeply SE or NW. Barite said to assay 97% $BaSO_4$.	About 2 mi. NE of O'Brien. Several cuts and 20-ft. adit. Idle. (Averill 39:114.)
	Austin	Sec. 29 T 34 N, R 3 W, MDB&M	United States Government.	Massive barite replaces bed of metamorphosed tuff in Pit Fm.	About 2 mi. SW of Bully Hill. The Glidden Co. shipped 1,500 to 2,000 tons ore to Oakland in 1921–22, 1924. Small quarry. Idle since 1924. (Logan 26:129; Bradley 30:56; Albers and Robertson 61:74.)
	Barite No. 1 and No. 2 (Noble)	Sec. 21 or 28, T 29 N, R 9 W, MDB&M	United States Government.	Barite vein (?) 2 ft. wide, said to be associated with minor witherite.	About 1½ mi. S of Platina, on Beegum Cr. Claims reportedly located 1916 or 1917. Small open cut. No production. Idle. (Logan 26:129; Bradley 30:57; Averill 39:114.)
	Bidwell	Sec. 2, T 34 N, R 1 W, MDB&M	Undetermined	Lenses or vein of barite 2 ft. wide.	About 2 mi. SW of Montgomery Creek, on SW side Willow Cr. Canyon. Shallow cuts. Idle. (Averill 39:114.)

BARITE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Bully Hill	Sec. 15, 16, 21, 22, 28, T 34 N, R 3 W, MD B&M	Glidden Company, Union Commerce Building, Cleveland, Ohio	Small bodies of medium-grained, massive or banded, light-gray to white barite replaces sheared rock along the Bully Hill shear zone. Bodies 1–2 ft. thick and several feet long are exposed near Adit 0. Barite consists of anhedral to subhedral tabular crystals, with poorly-defined cleavage.	At Bully Hill. (Albers and Robertson 61:74–75.)
	Exposed Treasure	Sec. 33, T 36 N, R 1 W, MDB&M	Undetermined	Dark gray barite of "apparently fair grade" is 4 ft. wide, crops out intermittently for 3,000 ft.	6 mi. S of Big Bend and about 2 mi. W of Hillcrest-Big Bend road. Pits as much as 22 ft. deep. No production. Idle. (Logan 26:129–130; Bradley 30:56.)
115	Glidden (Loftus)	Sec. 18, 19, T 38 N, R 3 W, MDB&M	The Glidden Company, Cleveland, Ohio; leased by Baroid Division National Lead Company, 111 Broadway, New York 6, New York		(Laizure 21:515; Logan 26:130; Bradley 30:56–57; Averill 31a:26–27; 39:114–115; herein.)
	Greenwood	Sec. 35, T 35 N, R 4 W, MDB&M	Southern Pacific Land Company, San Francisco	Said to be an 8-ft. width of barite.	About 2½ mi. NE of O'Brien, just N of Afterthought barite deposit, which see. Idle. (Averill 39:114.)
116	Hirz Mountain	Sec. 12, T 35 N, R 4 W, MDB&M	United States Government.	18-in. vein barite in Bragdon Fm. strikes N 50° E; dip nearly vertical. Analysis shows sp.g. 4.33, $BaSO_4$ 97.8%, silica 1%, iron plus aluminum oxides 1.2%.	About 6½ mi. NE of O'Brien, at W end of Hirz Mtn. Undeveloped.
	Loftus				See Glidden.
	Noble				See Barite No. 1 and No. 2.

CLAY

	Alta Lime and Brick Company (Coleman and Hill)	T 31 N, R 4 W, MDB&M.	Undetermined	4 ft. of tawny-colored, plastic clay grades downward into sand.	Along Sacramento River bottom, 1¼ mi. S of Redding. Brick was made in kiln dismantled long ago. Idle. (Aubury 06:256; Brown 16:756.)
	Coleman and Hill				See Alta Lime and Brick Company.
	Holt and Gregg	Sec. 9, T 30 N, R 4 W, MDB&M	U.S. Plywood Corporation, Anderson	Redding clay similar to that of Alta Lime and Brick Co., which see. 2 adjacent pits in Anderson contained clay 12–15 ft. thick and sandy clay 8 ft. thick, respectively.	At site of U.S. Plywood plant in Anderson. Formerly operated brickyard 1 mi. S of Redding; moved to Anderson around 1900. Clay there was worked by open cuts. Brick plant with 120-ft. stack had capacity of 40,000 bricks in 7 hrs. Idle since 1920. (Aubury 06:257; Brown 16:756; Logan 26:131; Dietrich 28:223.)
	Reading Homestead	Sec. 3, T 29 N, R 3 W, MDB&M	Undetermined	30 ft. of clay in deposit ¼ by 1 mi. in plan; capped by 15 ft. of gravel.	About 4 mi. E of Cottonwood. Undeveloped. (Aubury 06:257; Brown 16:756; Dietrich 28:223.)
	Redding Brick and Tile Company	Sec. 19, T 31 N, R 5 W, MDB&M	Undetermined		About 1 mi. N of Centerville. Brick formerly made in small kiln at Redding from clay taken from this deposit. Idle. (Brown 16:756; Dietrich 28:223.)
	Southern Pacific Company	Sec. 19, T 32 N, R 4 W, MDB&M	Southern Pacific Land Company, San Francisco	Clay bed crops out on both sides of gravel-capped hill.	About 1 mi. NE of Redding. Undeveloped. (Aubury 06:257; Brown 16:756; Dietrich 28:223.)

COAL

117	Barnes (Mt. Shasta Coal Company)	Sec. 4, T 33 N, R 1 W, MDB&M	Arthur H. Dakin, Box 621, Tiburon		(Weber 88:191; Logan 26:134; Averill 39:118–119; herein.)
	Beegum Creek	Sec. 31, 32 T 29 N, R 9 W, MDB&M	Undetermined	Hard, semi-bituminous coal in seam 4 in. to 3 ft. thick strikes W, dips 18° S, is capped by hard, silicified, fissile shale.	About 3½ mi. SW of Platina. Crosscut adit 10 ft. below outcrop cuts seam at 40 ft., follows it down dip for 35 ft. Idle. (Laizure 21:515; Logan 26:137.)
	Burckhalter				See Kosk Creek.
	Clover Creek	Sec. 4, T 32 N, R 1 W, MDB&M	Ray W. Byers, Box 67, Redding	Wide zone of badly broken rock.	6 mi. SE of Ingot. Active 1920s. 937 ft. adit trends N 12° E; 164-ft. extension is inclined at 45°. No production. Idle. (Logan 26:134–135.)
	Cook	Sec. 18, 19, T 33 N, R 1 W, MDB&M	Pauline J. Strawn; address undetermined	Coal has steep dip	About 3½ mi. SE of Ingot. Adit 180 ft. long. (Logan 26:135.)
	Cow Creek				See Dakin.
118	Dakin (Cow Creek)	Sec. 12, T 33 N, R 2 W, MDB&M	Harry Rutherford; address undetermined	Light, blocky lignite occurs in near-horizontal seams interbedded with clay and shale, capped by sandstone and basalt flow. Seams range from 6 in. to 2½	About 2 mi. E of Ingot. Adit driven about 60 ft. in 1876, cleaned out around 1887. By 1900, adit was 350 ft. long. Incline was sunk in mid-1920s. Idle since. (Weber 88:191; Laizure 21:516; Logan 26:135.)

COAL—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Dakin—Continued			ft. thick; lignite-bearing sequence is up to 14 ft. thick, with the greater part being lignite.	
	Frost	T 34 N, R 1 W, MDB&M.	Undetermined		In Round Mountain district. Prospect. Idle. (Logan 26:137.)
	Kincaid				See Luce.
119	Kosk Creek (Burckhalter)	Sec. 22, T 38 N, R 1 E, MDB&M	United States Government	2 beds of black, sub-bituminous coal interbedded with thin partings of clay and shale are separated from each other vertically by 17 ft. of fine-grained bluish sandstone. They strike W, dip 5° N, and are moderately faulted. 5 ft. of coal and minor interbeds crop out nearby, at falls on Coal Creek.	About 8 mi. NE of Big Bend. Prospected probably prior to 1900, with some development in 1920s(?). 80-ft. adit at creek level in lower of 2 beds; upper workings include adit and gentle, 130-ft. incline. Idle. (Logan 26:137; Averill 39:118.)
120	Luce (Kincaid)	Sec. 20, T 33 N, R 1 W, MDB&M	A. Luce, c/o Lorena L. Davanpack, 215 South Street, Willows	Lustrous black lignite or sub-bituminous coal dips 7° NE, occurs in bed 5–6 ft. thick with numerous beds and partings of bone and clay that are too thin to sort and thus adversely affect ash content. 5 ft of mixed shale, clay, and coal, including 2 ft. of clean coal, were cut by winze 80 ft. below first bed. 1 ft. of coal occurs 12 ft. lower. Coal is in Eocene or Cretaceous sandstone overlying metarhyolite.	About 5 mi. SE of Ingot. 45-ft. adit driven beginning 1874, caved by 1876. Property idle until worked 1923–26. Gentle, 320-ft. incline trends about S 80° E, with 105-ft. drift to N at end. From incline, raise put up and 45° winze sunk to bedrock at depth of 353 ft. Idle. (Goodyear 88:150; Brown 16:756–757; Logan 24:16–17; 26:135–136; Averill 39:117.)
	Mt. Shasta Coal Company				See Barnes, herein.

DIATOMITE

121	Cayton Creek group	Sec. 17, 18, 19, T 37 N, R 3 E, MDB&M	Undetermined	Flows of olivine basalt cap up to 200 ft. of volcanic lithic sandstone interbedded with massive diatomite. In 15-ft. adit 0.1 mi. E of Clark Creek Lodge, 4 ft. of light buff diatomite overlies 2½ ft. of limonitic, volcanic lithic sand, dipping gently W. Diatomite here has iron-stained vertical fractures and bedding planes, and encloses sparse pods or lenses of loose sand.	Just N of Lake Britton, about 10 mi. N of Burney. Several claims totaling about ¾ square mile. Located 1921–22. 4 short adits. No production. See also Mt. Shasta Silica Company. (Logan 26:165, 166.)
	D and E Mining Company	Sec. 2, 3, 4, T 36 N, R 2 E, & Sec. 34, 35, T 37 N, R 2 E, MDB&M	H. L. Smith and R. J. Dierking, 157 East Cypress, Covina		Leased 1,200 acres in Lake Britton area for 5 years from U.S. Forest Service in January 1963; will pay $1,200/year and 50 cents/ton royalty. Area involved includes parts of Shasta Diatomite and Sheep Springs deposits.
	Dicalite group (Shasta White No. 1, Snow White Nos. 1–4, and Tierra Blanca No. 2)	Sec. 2, 3, T 36 N, R 2 E, and Sec. 25, 35, T 37 N, R 2 E, MDB&M	Dicalite Division, Great Lakes Carbon Corporation, 18 East 48th St., New York 17, N.Y.	Logan reports an analysis of diatomaceous earth from Sec. 25: SiO_2 91.33%; Fe_2O_3 0.92%; Al_2O_3 2.59%; CaO 0.66%.	About 9 mi. N of Burney. About 1,100 acres unpatented association placer claims, and 160 acres patented. Assessment work only. No production. (Logan 26:166.)
	Hat Creek—Pit River Basin	Sec. 7, 8, 9, 10, 15, 16, 17, 18, 19, 20, 21, 29, T 36 N, R 4 E; Sec. 1, 12, 13, T 36 N, R 3 E; and Sec. 36, T 37 N, R 3 E, MDB&M	Undetermined	Up to 500 ft. of Pliocene continental sediments are capped by flows of basalt. Sediments exhibit foreset bedding near periphery of basin, are only slightly deformed, and consist chiefly of friable, volcanic lithic sandstone, volcanic ash, and scattered beds of diatomite. Near Hat Creek bridge on Highway 299, 50 ft. of diatomite is massive, white, and punky; it has only minor discoloration and little overburden. Hanna reports abundant large, elongate **Pinnularia,** a few **Melosira,** and some **Navicula, Stephanodiscus, Cyclotella,** and **Stauroneis** in sample taken 0.2 mi. W of bridge. About 125 ft. of massive white diatomite are exposed along Hat Creek S of PG&E powerhouse, in Sections 20 and 29.	About 8–10 mi. NE of Burney. Comprises approximately 9½ square miles. Some prospecting done here, probably in conjunction with work on Insulator group, which see. (G D. Hanna, pers. comm., 1959.)
122	Insulator group	Sec. 19, 30, 31, T 37 N, R 4 E; Sec. 21, 22, 23, 24, 25, 26, 27, 36, T 37 N, R 3 E; Sec. 1, 12, T 36 N, R 3 E; and Sec. 7, T 36 N, R 4 E, MDB&M	Undetermined	Flows of andesite and basalt cap up to 400 ft. of Pliocene continental sediments, including scattered beds of compact, apparently pure diatomite up to 20 ft. thick. Diatomaceous earth, consisting of diatomite	Just N and E of Lake Britton, about 11 mi. NE of Burney. Numerous claims totaling about 6½ square miles. Located 1921–22. 25 adits, several pits. Large grinding and sizing plant built late 1920s but probably never used. Production consisted of small lots used locally as insulation in commercial refrigerators. J. W. Doty of Chico leased property

DIATOMITE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Insulator group—Continued			mixed with variable proportions of volcanic gravel, sand, and clay, is common. Diatomite locally is white, but commonly is stained with yellowish oxides; density and compactness are variable. Logan (1926, p. 166) reports 4 analyses of diatomaceous earth from this property, with the following ranges: SiO_2 81.39–90.28%; Fe_2O_3 0.65–2.18%; Al_2O_3 1.55–8.32%; CaO 0.15–2.27%. Hanna reports abundant **Melosira granulata** and common **Stephanodiscus** in sample taken at SW corner Sec. 27.	in 1947; 100 tons diatomite were mined in May and June, and used in manufacture of concrete blocks in Chico and Richfield. Idle since then. See also Mt. Shasta Silica Company. (Logan 26:163–166; Averill 39:128–129; G D. Hanna, pers. comm., 1959.)
	Mount Shasta Silica Company	.....	.....	.....	This company held claims of the Cayton Creek, Insulator, Shasta Diatomite, and Sheep Springs groups, which see, beginning in 1921. Holdings amounted to about 10 square miles. 10,400 acres transferred to W. C. Crittenden in 1930, and from him to General Kieselguhr Corp. Mt. Shasta Silica Co. has since disbanded, and some of its claims now are held by Great Lakes Carbon Corp. (Logan 26: 163–166; Averill 39:128–129.)
	Shasta Diatomite group....	Sec. 2, 3, T 36 N, R 2 E, (proj.), and Sec. 34, 35, T 37 N, R 2 E, MDB&M	Undetermined.....	White, lightweight diatomite exposed in adits is capped by volcanic rock. Hanna reports abundant **Melosira granulata** and common **Stephanodiscus** in sample from pit in NW¼ Sec. 2.	About 9 mi. N of Burney. Claims total 2¼ square miles. Located 1921–22. 2 short adits. Idle. (Logan 26:165; G D. Hanna, pers. comm., 1959.)
	Shasta White No. 1.....	.....	.....	.....	See Dicalite group.
123	Sheep Springs.....	Sec. 26, 35, T 37 N, R 2 E, MDB&M	Undetermined.....	Soft, white diatomite. Logan (1926, p. 166) reports 2 analyses of diatomaceous earth from this property: SiO_2 90.58–96.02%; Fe_2O_3 0.62–0.65%; Al_2O_3 1.03–1.43%; CaO 0.12–0.27%.	About 11 mi. N of Burney. Claims total ⅝ square mile. Located 1921–22. Adit and several pits. No production. Idle. (Logan 26:165, 166.)
	Snow White Nos. 1–4....	.....	.....	.....	See Dicalite group.
	Stewart and Moore.....	Sec. 20, T 31 N, R 1 E, MDB&M	Undetermined.....	White diatomaceous earth with thin overburden. Extent of deposit unknown.	2 mi. N of Shingletown. Located 1925. 3 shallow pits. Idle. (Logan 26:166.)
	Tierra Blanca No. 2.....	.....	.....	.....	See Dicalite group.

GRAPHITE

	Wood.....	Sec. 1, T 33 N, R 4 W, MDB&M	Rodney Wood et al., P.O. Box 1192, Redding	Thin-bedded argillite strikes generally N, dips steeply W. Steeply-dipping, carbon-rich lenses of broken rock a few inches to 4 ft. wide and several feet long are associated with W-trending, vertical shear zone. 400–500 lbs. selected material assayed 10–25% carbon.	Near Cove Creek, about 1 mi. E of Gray Rocks. 125-ft. open cut with 20-ft. face. No commercial production.

LIMESTONE

	Alta Lime & Brick Company	Sec. 22, T 34 N, R 5 W, MDB&M	E. J. Gorman; address unknown	Limestone of Devonian Kennett Fm.	About 4½ mi. N of Shasta Dam. Road to quarry and kiln with capacity of 8 tons/24 hrs. under construction in 1904. No activity reported since. (Aubury 06:90; Logan 47:324.)
124	Asher.....	Sec. 1, 2, T 33 N, R 2 W, MDB&M	Ingot Lime Products Company, c/o Frank T. Bell, Ephrata, Washington; also L. W. and Lillie Hendrix, and L. E. and P. B. Grannis, Bella Vista	Abrupt bluffs of bedded, dark, hard, and somewhat siliceous limestone; fossils are common, and corals predominate in upper part. Logan (1947, p. 325) reports analyses and averages of 11 random samples taken N of Highway 299; ranges of values and averages are given here: 0.59–4.55, 2.63% SiO_2; 0.20–1.81, 0.54% R_2O_3; 92.99–98.81, 96.17% $CaCO_3$; 0.21–0.66, 0.46% $MgCO_3$. Ranges of values and averages of 3 random samples taken at ammonite locality 0.2 mi. E of quarry in 1954 follow (Bowen): 0.56–2.20, 1.10% SiO_2; 0.17–0.28, 0.23% Fe_2O_3; 0.27–0.75,	2 mi. NE of Ingot; part of the limestone extends a few hundred feet N into SW¼ Sec. 36, T 34 N, R 2 W. Small quarry. Idle. (Logan 47:324–325; O. E. Bowen, Jr., pers. comm., 1958.)

LIMESTONE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Asher—Continued			0.45% Al_2O_3; 53.36–54.65, 54.16% CaO; 95.23–97.53, 96.66% $CaCO_3$ (using factor of 1.7847); 0.39–0.52, 0.47% MgO; 0.07–0.33, 0.16% P_2O_5.	
	Bayha Land Company				See Calaveras Cement Company, herein.
	Bear Mountain	Sec. 7, T 33 N, R 3 W, MDB&M	Undetermined	Small bed of limestone is exposed along road on E side of mountain, Logan reports 0.96% SiO_2, 0.58% Fe_2O_3 + Al_2O_3, 97.18% $CaCO_3$, 0.69% $MgCO_3$.	About 11 mi. NE of Redding. Undeveloped. (Logan 47:325.)
	Bibbens	Sec. 35, T 34 N, R 2 W, MDB&M	Charlene Bibbens, Oak Run	Logan reports 1.87% SiO_2, 0.26% Fe_2O_3 + Al_2O_3, 97.29% $CaCO_3$, 0.24% $MgCO_3$	About 2 mi. NE of Ingot, near SE corner of section. Extension of Asher deposit, which see. Undeveloped. (Logan 47:325.)
125	Briggsville (Mooretown)	Sec. 31, T 31 N, R 5 W, MDB&M	G. E. Oaks, 1737 Yuba Street, Redding	Lens of dark limestone in slate of Kennet (?) Fm. is almost 100 ft. thick, several hundred feet long; dips E into hill. Logan (1947) reports 3.67% SiO_2, 0.24% R_2O_3, 95.14% $CaCO_3$, 0.56% $MgCO_3$. Ranges of values and averages of 3 random samples taken north of Clear Creek road (Bowen) are: 1.64–2.58, 2.19% SiO_2; 0.08–0.11, 0.10% Fe_2O_3; 0.21–0.41, 0.33% Al_2O_3; 52.16–53.94, 53.50% CaO; 93.09–96.27, 94.43% $CaCO_3$ (using factor of 1.7847); 0.53–1.46, 1.05% MgO; 0.01–0.06, 0.03% P_2O_5.	About 7 mi. SW of Redding, near Saeltzer dam. Small amount of lime produced from stone kiln prior to 1893. Active briefly in 1926, when a few hundred tons slaked lime were produced and sold for agricultural use. Idle since. (Fairbanks 93:42, Aubury 06:90–91; Logan 26:197; Averill 39:164; Logan 47:326; O. E. Bowen, Jr., pers. comm., 1958.)
126	Brock Mountain	Sec. 8, T 34 N, R 2 W, MDB&M	United States Government.	Crudely-defined beds of Hosselkus Limestone dip 10°–20° SE, are about 300 ft. thick. Rock is dense, fine grained, and dark; contains sparse small replacement patches of dolomite. Diller reports 51.0% CaO (91.02% $CaCO_3$, using factor of 1.7847), 1.5% Fe_2O_3 + Al_2O_3, 4.0% insoluble. Bowen reports 2 analyses of random samples: 0.85 & 2.3% SiO_2, 0.25 & 0.37% Al_2O_3, 0.16 & 0.25% Fe_2O_3, 54.5 & 53.5% CaO (97.27 & 95.48% $CaCO_3$, using factor of 1.7847), 0.68 & 1.02% MgO, and 0.9 & 0.9% P_2O_5.	6½ mi. N of Ingot, near saddle dividing Brock Mountain and Gray Rocks. Quarry operated 1903–10, supplied rock for flux to Bully Hill and Afterthought smelters. (Diller 04:176; Logan 47:325–326; O. E. Bowen, Jr., pers. comm., 1962.)
127	Calaveras Cement Company (Bayha Land Company, Gray Rocks, Lime Mountain Consolidated)	Secs. 2 and 3 (limestone quarry), and Secs. 9 and 16, (plant and shale quarry), T 33 N, R 4 W, MDB&M	Calaveras Cement Company, Div. of The Flintkote Company, 2244 Beverly Blvd., Los Angeles 57		(Averill 39:164; Logan 47:327; herein.)
	Doak	Sec. 23, T 34 N, R 4 W, MDB&M	United States Government.	Limestone is dark gray and massive in lower portion, lighter-colored and somewhat more thinly bedded above; contains many nodules and lenses of chert. For ranges and analyses of samples taken from Secs. 13, 14, and 23, see Moxley.	About 2 mi. SE of O'Brien, N of Shasta Iron Co. property. Limestone underlies most of E half of the section, but only the S extension of the deposit in Sec. 26 has been worked, by Shasta Iron Co., which see. (Tucker 23a:70; Averill 39:164; Logan 47:326.)
128	Emerald Glen	Sec. 1, T 33 N, R 2 W, and Sec. 6, T 33 N, R 1 W, MDB&M	R. M. and N. L. Emerald, 834 Orange Ave., Sunnyvale	Hosselkus Limestone (or Pit Formation?). Logan (1947, p. 327) reports 6 analyses of random samples from Sec. 6 and "nearby" in Sec. 36, T 34 N, R 2 W. Ranges and averages are: 0.63–3.39, 1.99% SiO_2; 0.28–0.50, 0.37% R_2O_3; 95.52–98.30, 96.89% $CaCO_3$; 0.21–0.52, 0.38% $MgCO_3$.	About 3 mi. NE of Ingot. Undeveloped. (Logan 47:326–327.)
	Gray Rocks				See Calaveras Cement Company, herein.
129	Holt and Gregg (Kennett Lime Rock quarry)	Sec. 34, T 34 N, R 5 W, MDB&M	United States Government.	Fine-grained limestone of the Middle Devonian Kennett Fm. is cut by white calcite veinlets. Irelan (1888) reports 95.2% $CaCO_3$, 0.5% MgO, 4.4% SiO_2, and Crawford (1896) reports 97% $CaCO_3$, 2% MgO, 1% SiO_2. Most of Shasta County's total yield by 1926 of 711,064 tons limestone and 244,778 bbls. lime came from this property (Logan 1947, p. 324). In 1937, Golinsky mine furnace was charged with 160	3 mi. N of Shasta Dam. Old quarry on ridge crest known as Kennett Lime Rock quarry, first worked in 1884 and rock burned in kilns on Backbone Creek. Around 1900, a new quarry was opened a short distance SE of old one, and 3 new kilns with combined capacity of 25 tons/24 hrs. were built at Kennett. Broken limestone for use as flux in smelters at Kennett and Keswick, and burned lime sold commercially, were produced for many years. Quarry became idle when Kennett smelter closed in 1925. In 1937, Backbone Gold Mining Co. quarried limestone here for use as flux in 50-ton Mace furnace at Golinsky mine. Idle since. (Irelan 88:572; Crawford 94:395; 96:632; Diller 04:177;

LIMESTONE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Holt and Gregg —Continued			lbs. limestone for each 300 lbs. sulfide ore (Averill 1939, p. 125); total ore production of 3,189 tons (Kinkel et al. 1956) thus implies limestone production of 1,700 tons.	06:14; Aubury 06:90–91; Brown 16:806; Averill 39:125, 164–165; Logan 47:324, 327–328; Kinkel et al. 56:114.)
	Ingot Lime Products Company	In 4 sections common to corner of T 33 N and T 34 N, and R 1 W and R 2 W, MDB&M	c/o Frank T. Bell, Ephrata, Washington	.....	About 3 mi. NE of Ingot. Holdings include former Asher quarry, which see. Work done there during 1953–54 probably was done under lease by Redding Lime Products Co., which see.
	Kennett Lime Rock quarry	.....	.....	.....	See Holt and Gregg.
	Lassen Lime Products Company	.....	.....	.....	Formed by E. C. Handt and Frank D. Fewell in mid-1950s. Probably a successor to Redding Lime Products Co., which see. Had interest in limestone properties in Ingot area.
	Lime Mountain Consolidated	.....	.....	.....	See Calaveras Cement Company, herein.
	Mooretown	.....	.....	.....	See Briggsville.
	Mountain Copper Company	Sec. 32, T 34 N, R 5 W, MDB&M	Mountain Copper Company of California, 100 Mococo Rd., Martinez	Limestone of Middle Devonian Kennett Fm. Kinkel et al. (1956) report an analysis of a random sample taken in Sec. 4, T 33 N, R 5 W, probably from near this deposit: 0.22% SiO_2, 0.12% Fe_2O_3, 0.26% Al_2O_3, 99.84% $CaCO_3$, 0.0% MgO.	3 mi. NW of Shasta Dam. Limestone quarried near SE corner of section was used as flux in Keswick smelter. Smelter began operation in 1896, and use of this deposit ceased "some years" prior to 1906. (Aubury 06:91; Logan 47:329; Kinkel et al. 56:37.)
	Moxley	Sec. 13, T 34 N, R 4 W, MDB&M	L. J. Gerard and T. R. Woods, P.O. Box 626, Redding	Extensive deposit of fine grained, medium-gray McCloud Limestone; lenses and pods of chert comprise an average of 10% of the formation (Albers and Robertson, 1961). Ranges and average values of 4 analyses of slightly weathered limestone from Sections 13, 14, and 23 (Logan 1947) are: 0.41–1.02, 0.66% SiO_2; 0.20–0.49, 0.32% Fe_2O_3; 0.40–0.64, 0.54% Al_2O_3; 0.75–2.34, 1.47% $MgCO_3$; 96.07–98.09, 96.77% $CaCO_3$. An uncredited analysis given with these, and earlier by Logan (1926, p. 194), but not included here, was first reported by Tucker (1923a p. 70): 1.10% SiO_2, 0.20% Fe_2O_3, 0.24% Al_2O_3, 2.38% MgO, 52.16% CaO (93.09% $CaCO_3$, using factor of 1.7847). Although Tucker gives the sample locality as "opposite the United States Fishery", which thus should be Sec. 23, he implies (p. 69) that Sec. 13 is intended.	3 mi. E of O'Brien. Adjacent to Doak and Shasta Cement Materials Co. properties, which see. Undeveloped. (Tucker 23a:69–70; Logan 26:194–195; Averill 39:165; Logan 47:328; Albers and Robertson 61:22.)
	Redding Lime Products Company	.....	.....	.....	Company formed by Herbert L. Wadell of Redding in 1952. Had interest in limestone properties in Ingot area 1952–54(?). Crushing and screening plant built at Asher quarry and operated briefly in 1954; only a small quantity of rock was processed. Probably associated with Ingot Lime Products Co., which see.
	Shasta Cement Materials Association	Sec. 13, 14, 16, 23, T 34 N, R 4 W, MDB&M	United States Government.	McCloud Limestone of Permian age. For analyses see Moxley. Shale deposit in Sec. 16 near O'Brien is ½ mi. wide, consists of more than 300 ft. of lightly metamorphosed shale, mudstone, and siltstone of Bragdon Fm. Tucker (1923a) reports an analysis as follows: 57.51% SiO_2, 19.85% Al_2O_3, 8.28% Fe_2O_3, 2.98% CaO, 2.61% MgO, 0.81% TiO_2, 1.34% Mn_3O_4, 3.16% alkalies (by diff.), and 4.46% ignition loss.	About 2½ mi. SE of O'Brien. Company formed in 1920s to develop limestone NE of Pit and McCloud Rivers; it held claims of 320 acres in Secs. 14 and 23, an option on 622 acres in Sec. 13 (Moxley property, which see), and 320 acres patented on shale in Sec. 16. Company interests were held through the 1930s and probably into the mid-1940s. Undeveloped. (Tucker 23a:71; Logan 26:195; Averill 39:165–166; Logan 47:329.)
130	Shasta Iron Company	Sec. 26, T 34 N, R 4 W, MDB&M	Shasta Iron Company, c/o Bunker Hill Iron Exploration, 620 Market St., San Francisco 4	McCloud Limestone. Diller (1904) reports analysis of rock shipped to smelter: 1.5% $Fe_2O_3 + Al_2O_3$, 2.0% insoluble, 52.5% CaO (93.70% $CaCO_3$, using factor of 1.7847). Aubury (1906) reports partial analysis of similar shipments: 3% insoluble, 54.5% CaO (97.27% $CaCO_3$, using factor of 1.7847). Prescott (1908) reports: 1.2% SiO_2, 0.5% Al_2O_3, 0.2% FeO, 53.8% CaO (96.02% $CaCO_3$, using factor of 1.7847), 1.1% MgO. Tucker	1 mi. NE of junction Pit and McCloud Rivers. Rock quarried and shipped to Bully Hill smelter 1901–02; Noble Electric Steel Co. leased property from 1907 to end of World War I and quarried limestone for their own smelters during this time; during June-Dec. 1922, 12 railroad cars of rock were shipped each month for use in new smelter of Shasta Zinc and Copper Co. at Bully Hill. In 1922, quarry face was 200 ft. long, 100 ft. high. Idle since then. (Diller 04:176; Aubury 06:90; Prescott 08; Tucker 22:733; 23:12; Logan 26:195–196; Averill 39:166; Logan 47:329–330.)

LIMESTONE—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Shasta Iron Company —Continued			(1922) gives a very similar analysis. Logan (1947, p. 330) reports 2 analyses made prior to 1912 by Noble Electric Steel Co.: 97.57 & 97.65% $CaCO_3$; 0.76 & 0.72% $MgCO_3$; 0.52 & 0.45% Fe_2O_3; 0.64 & 0.41% Al_2O_3; 0.41 & 0.40% insoluble.	

MINERAL SPRINGS

131	Big Bend Hot Springs.....	Sec. 36, T 37 N, R 1 W, MDB&M	Martha E. Lofton et al., Big Bend	Water with temperature of 140°–180° F issues at several places along 350 yds. of S bank of Pit River; contains calcium, iron, and sulfur. Largest spring has flow of 25 gal./min.	At Big Bend. Used locally for "rheumatic troubles" in 1890s; small resort around 1906. (Crawford 96: 519–520; Brown 16:808; Logan 26:199; Averill 39:167.)
132	Castle Crag Spring (Lower Soda Spring)	Sec. 11, 12, T 38 N, R 4 W, MDB&M	Undetermined.....	Water strongly alkaline-saline, contains sodium, calcium, iron, magnesium, chloride, and carbonate.	About 2½ mi. NE of Castella, ⅔ mi. E of Sacramento River. Resort located here in 1920s. (Logan 26:199; Averill 39:168.)
	Castle Rock Springs.....	Sec. 14, 15, T 38 N, R 4 W, MDB&M	Undetermined.....	Five springs with temperature of 40° F contain sodium chloride, sodium carbonate, potassium, and trace of lithium. Flow averages 2,000 gal./day.	On Sacramento River about ¾ mi. NE of mouth of Castle Creek. Water sold commercially in 1910s and 1920s. (Waring 15:227; Brown 16:808; Logan 26:199; Averill 39:168.)
	Lower Soda Spring.....	.....	.....	.....	See Castle Crag Spring.
133	Mountain Spring Water Company	Sec. 6, T 31 N, R 4 W, MDB&M	Larry Tilden, 2610 Henderson Road, Redding	.....	Herein.

PUMICE, PUMICITE, and VOLCANIC CINDERS

√ 134	Black Butte.....	Sec. 17, T 30 N, R 1 W, MDB&M	H. N. Hackler, Cassel....	Stratified cinders of large cone form 30° dip-slope to W. 3–8 ft. overburden of brown cinders, ash, and soil. Sparse basalt blocks up to 3 ft. across; masses of agglutinated cinders up to 1 ft. across. Cinders dominantly black, with sparse red scattered throughout; commonly have tan coating of dust. Sizes greater than 3 in. common. Sieve analyses follow (1 by Cal. Div. Highways, 1951; 6 by Shasta Co. Dept. Pub. Works, 1961):	6½ mi. SW of Shingletown. Pit in W flank of Black Butte is at least 12 years old. Pit face more than 500 ft. long, up to 100 ft. high. Mined under lease by Shasta County, Cal. Div. Highways, and P.G.&E., using front-end loaders, trucks; some material is crushed and screened before using.
	Brush Mountain.....	Sec. 36, T 36 N, R 3 E, and Sec. 1, T 35 N, R 3 E, MDB&M	Undetermined.....	N pit has red cinders only; S pit has interlayered red and black cinders. Tests on material from S pit gave following results (Cal.	Five mi. NE of Burney, near summit of mountain. 2 pits, N and S of summit. Used by Cal. Div. Highways for untreated road base during 1960s.

Size	Percent pass C.D.H.	Shasta County range	Shasta County aver.
2 in.	100		
1½ in.	98	95–99	98
1 in.	94		
¾ in.	87	89–94	91
⅜ in.	57	52–81	69
4 mesh	23	16–44	34
8 mesh	10	8–26	17
16 mesh	7	5–20	11
30 mesh	7	4–16	8
50 mesh	7	3–13	7
100 mesh	6		
200 mesh	5	1–5	3
270 mesh	4		

L.A. Rattler test on pit-run cinders gave 7.5% and 7.1% at 100 rev., and 33.1% and 36.1% at 500 rev. for red and black cinders respectively; sand equivalent of 13 random samples ranges from 31 to 62, averages 40; that of overburden is 24 (Shasta Co. Dept. Pub. Works, 1961).

PUMICE, PUMICITE, and VOLCANIC CINDERS—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Brush Mountain —Continued			Div. Highways): sand equivalent 42, moisture 5.5%. Size — Percent pass 2½ in. — 100 2 in. — 97 1½ in. — 88 1 in. — 77 ¾ in. — 66 ⅜ in. — 54 4 mesh — 45 8 mesh — 37 16 mesh — 31 30 mesh — 25 50 mesh — 18 100 mesh — 12 200 mesh — 7	
135	Doyle Butte	Sec. 31, T 35 N, R 4 E, & Sec. 6, T 34 N, R 4 E, MDB&M	Fruit Growers Supply Co., Box 2706, Terminal Annex, Los Angeles 54	Stratified volcanic cinders, poorly sorted. Overburden of ash, soil, and white, solfatarized cinders 1–3 ft. thick. Material black except for band of red cinders 4 ft. thick near surface at center of E-W face, about 2% red cinders distributed evenly throughout, and some tan cinders near the overburden. About 5% of cinders are +2 in. Tests (Cal. Div. Highways, 1956–57) show sand equivalent of 86 for cinders and 61 for overburden, 2.9% moisture in overburden, and cinder sizes (2 samples) as follows. Size — Percent pass 2 in. — 98–100 1½ in. — 97–99 1 in. — 92–97 ¾ in. — 81–96 ⅜ in. — 55–92 4 mesh — 36–83 8 mesh — 22–58 16 mesh — 13–38 30 mesh — 8–21 50 mesh — 5–10 100 mesh — 3–4 200 mesh — 1–2	5½ mi. SE of Burney. Pit active at least 7 years. Cut on S and E sides of cone near summit is 300 ft. long, has face 25 ft. high and bench 50–100 ft. wide. Inactive in December 1962.
136	Hackler	Sec. 8, T 30 N, R 1 W, MDB&M	H. N. Hackler, Cassel	All pits are in extensive deposit of Holocene cinders overlying Pleistocene flow of olivine basalt. In N pit, mixed black and tan cinders are well stratified, dip 6°–12° S. Hard, bedded, light-gray and black sand up to 6 ft. thick, exposed in E half of pit near floor, is compacted against sparse, large boulders derived from weathering of underlying basalt flow. Little overburden. In SW pit, stratified cinders are black only, dip 2°–12° N. Overburden up to 8 ft. thick consists of lapilli, ash, and soil; some trees and brush. Sparse altered or cemented zones occur in upper part of face, near overburden. Average size range is ¼–¾ in.; plus-2-in. cinders uncommon. In SE pit area, mixed black and tan cinders dip 12° N. Occasional hard layers up to 2 in. thick consist of white, solfatarized ash matrix enclosing 25% lapilli cinders. Average cinder size about ½ in., but fine, crossbedded lapilli cinders and ash at E end of area averages less than ¼ in. Tests on 2 samples from unspecified portions of Hackler property (Cal. Div. Highways, 1946, 1951) show specific gravity of 2.72 for −4 mesh, 1.45 for +4 mesh, and sizes as follows: Size — Percent pass ¾ in. — 100 ⅜ in. — 95–97 4 mesh — 75–81 8 mesh — 52–57 16 mesh — 28–33 30 mesh — 12–16 50 mesh — 5–8 100 mesh — 4–6 200 mesh — 2–4 270 mesh — 2–3	Six mi. SW of Shingletown. Property intermittently active for at least 16 years. 2 pits S of Ash Creek; W pit leased by Stewart Masonry Supply, which see herein. 1 pit N of Ash Creek. N pit has 300-ft. face, 2 benches with total height of 15 ft.; SW pit has semi-circular face 200 ft. long, 20 ft. high; SE pit area consists of several small pits and trenches 5–20 ft. deep, extending for 300 ft. in E-W direction.

PUMICE, PUMICITE, and VOLCANIC CINDERS—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
137	Horr	Sec. 21, T 38 N, R 4 E, MDB&M	Harry Horr, Glenburn	Stratified volcanic cinders, largely agglutinous, with randomly distributed blocks of massive basalt up to 3 ft. across. Black material dominant, but locally cinders and bombs are entirely red. Agglutinous material is light and brittle, should crush easily. Plus-3-in. material abundant. Tests on mixed cinders and overburden (ratios 9:1 and 8:2) showed 19.1%–21.4% moisture and compacted dry weight of 91.5–93.3 lbs./cu. ft.; sieve analysis of pit-run sample follows (Cal. Div. Highways, 1946): Size — Percent pass ¾ in. — 100 ⅜ in. — 99 4 mesh — 94 8 mesh — 80 16 mesh — 69 30 mesh — 54 50 mesh — 39 100 mesh — 30 200 mesh — 25 270 mesh — 24	7 mi. NW of McArthur. Intermittently active for at least 16 years. 3 connected pits with serrate faces totalling several hundred feet in length. 10–25 ft. deep. Mined under lease by Shasta County and Cal. Div. Highways.
138	Maahcooatche	Sec. 9, T 34 N, R 4 E, MDB&M	Shasta County	Poorly stratified cinders at base of steep slope; color black except for 10–15 ft. of tan cinders below overburden. 1–2 ft. of overburden. Material contains about 2% plus-8-in. and about 15% plus-2-in. basaltic blocks and cinders. Sieve analysis of minus-2-in. material follows (Cal. Div. Highways, 1959): Size — Percent pass 2 in. — 100 1½ in. — 94 1 in. — 84 ¾ in. — 70 ⅜ in. — 45 4 mesh — 30 8 mesh — 21 16 mesh — 15 30 mesh — 12 50 mesh — 9 100 mesh — 5 200 mesh — 3	8½ mi. SE of Burney. Intermittently active for more than 15 years. Shasta County Dept. Pub. Works mined, crushed, and stockpiled 12,000 yds. during summer 1962. Mined by lessees in December 1962, using 2 small scrapers, front-end loader, and trucks. Pit 350 ft. long at base, has several benches with total height of 150 ft.
	Peeler	Sec. 19, T 36 N, R 5 E, MDB&M	United States Government	Part of extensive deposit along N part of Hat Creek rim. Well bedded, well sorted lacustrine (?) cinders dip 5° SE. Beds 4–12 in. thick contain black cinders and dark, glossy, pumiceous scoria. Average size range ⅛–¼ in.; very little plus-3-in. material.	4½ mi. S of Fall River Mills. Intermittently active 1950s, included in wildlife withdrawal 1957. 2 pits; one with irregular faces 40 ft. high, another with 15-ft. faces; diameter of both about 100 ft. Mined by front-end loader and truck. Used by Shasta County Dept. Pub. Works under free-use permit from U.S. Bureau of Land Management.
139	Perk-O-Lite	Sec. 23, T 36 N, R 5 E, MDB&M	Milton Perkins et al., Pittville Route, McArthur	Pit in low, wide hill contains black cinders in SW part, red cinders in NE part. Some scoria masses up to 1 ft. across, but average cinder size ranges from ½ to 1½ in. A few short, dikelike masses of gray olivine basalt exposed in pit are avoided during mining.	6½ mi. SE of Fall River Mills. This pit and a pumice pit in NW Lassen County supply material to the Perk-O-Lite concrete block plant ½ mi. SE of Pittville. Large, shallow pit with little overburden, some trees. Mined by bulldozer and small scraper, processed by small, portable crushing and screening plant with 1½-in. grizzly and ⅜-in. jaws. Some pit-run material used without processing. Active in December 1962. Perk-O-Lite marketing area includes NE Shasta County.
140	Pit No. 1	Sec. 35, T 37 N, R 4 E, & Sec. 11, T 36 N, R 4 E, MDB&M	Pacific Gas and Electric Company, 245 Market Street, San Francisco	Stratified cinders dip 30° S, are part of cone enclosed by thick sequence of basalt flows. Color dominantly red, but prominent zone of black cinders occurs in E part of face. White solfatarized cinders are confined to upper 2–4 ft. of pit face and to small, local zones in face interior. Flanks of deposit are capped by flows of basalt that increase in thickness from upper part of face to road level. Cinders contain about 10% plus-2-in. material. Tests (Cal. Div. Highways, 1947, 1959) on pit-run material show 1.7% moisture and sand equivalent of 96 for coarse material, and 12.8–17.6% moisture for fine	2½ mi. W of Fall River Mills, adjacent to Highway 299. Intermittently active for at least 16 years. Mined under lease by Shasta County and Cal. Div. Highways. Pit cut in steep slope; face is 300 ft. long, 150 ft. high.

PUMICE, PUMICITE, and VOLCANIC CINDERS—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Pit No. 1—Continued			material; size analyses for the 2 types are: Size — Percent pass 3 in. — 83 2½ in. — 83 2 in. — 82 1½ in. — 100–79 1 in. — 93–75 ¾ in. — 87–71 ⅜ in. — 73–63 4 mesh — 60–53 8 mesh — 54–43 16 mesh — 47–35 30 mesh — 36–28 50 mesh — 26–18 100 mesh — 16–10 200 mesh — 8–5	
141	Potato Butte	Sec. 17, T 32 N, R 5 E, MDB&M	United States Government.	Well-stratified angular fragments of basalt and subround to round cinders and scoria are cross-bedded, form dip slope to W. Some clayey strata 1–12 in. thick. Basalt fragments range up to 10 in.; about 5% of deposit is of plus-2-in. size. Tests (Cal. Div. Highways, 1953) show specific gravity 2.51–2.64 (−4 mesh) and 1.78–2.09 (+4 mesh), sand equivalent 58, and size ranges as follows: Size — Percent pass 1½ in. — 97 1 in. — 87–89 ¾ in. — 76–80 ½ in. — 61–66 ⅜ in. — 48–55 4 mesh — 30–32 8 mesh — 24–25 16 mesh — 20–21 30 mesh — 17–18 50 mesh — 14–15 100 mesh — 12–13 200 mesh — 10–11	On W flank Potato Butte, 1¼ mi. E of Old Station Post Office. Used by Cal. Div. Highways for road surfacing. Quarry has 2 benches 12 and 15 ft. high, 500 ft. long. Mined by heavy bulldozer, front-end loader, and trucks. Active 1962.
142	Sanford	Sec. 1, T 35 N, R 4 E, MDB&M	Willis Sanford, Glenburn.	Isolated group of 3 cones. Volcanic cinders in main pit are black, well stratified; 1–2 in. sizes common, blocks up to 12 in. sparse. Pit S of road has mostly red cinders; black cinders exposed in W end of pit face. Ash-size cinders are common, but local zones average 2 in. Tests (Cal. Div. Highways, 1959) show compacted density of red cinders is 78 lbs./cu. ft.; moisture content of both types is 0.7–6.9%, and sizes are as follows: Size — Percent pass red — Percent pass black 3 in. — 100 2½ in. — 98 2 in. — 100 — 96 1½ in. — 97 — 93–94 1 in. — 96 — 90–91 ¾ in. — 88 — 81–82 ⅜ in. — 74 — 65–67 4 mesh — 61 — 49–52 8 mesh — 49 — 37–40 16 mesh — 41 — 29–32 30 mesh — 32 — 21–24 50 mesh — 21 — 13–16 100 mesh — 11 — 7–10 200 mesh — 5 — 3–5	5½ mi. SW of Fall River Mills. Intermittently active for several years. 3 pits. Main pit N of county road has 2 benches 150 and 100 ft. long, 25–40 ft. high; pit S of road has 100-ft. face 60 ft. high. Desired sizes of cinders obtained by selective mining with front-end loader, screening. Blake crusher installed in 1963. Material used for road base, leach lines, landscaping.
	Sixmile Hill	Sec. 30, T 36 N, R 5 E, MDB&M	Undetermined	Compact, evenly-layered, black cinders; locally slightly agglutinated. Fragments of black, frosted pitchstone abundant. Bedding compacted around sparse basalt blocks. Cinders overlain by coarse, buff-colored, volcanic lithic sand that contains round and subround grains.	About 5 mi. SW of Fall River Mills. Small pit.
143	Stewart Masonry Supply (plant only)	Sec. 24, T 31 N, R 5 W, MDB&M. (proj.)	Stewart Masonry Supply, 6401 Eastside Road, Redding		Herein.
	Sugarloaf Peak	Sec. 1, T 33 N, R 4 E, MDB&M	Undetermined	Black volcanic cinders up to 1 ft. across; average size less than 1	5 mi. NW of Old Station. Pit on NW side of cone has face 125 ft. wide, up to 70 ft. high. Cinders

PUMICE, PUMICITE, and VOLCANIC CINDERS—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Sugarloaf Peak—Continued			in. in upper part of face, somewhat larger below. Large blocks are cellular, have low bulk density. 2–4 ft. of soil overburden, some trees.	mined by front-end loader, passed through 1-in. vibrating screen.

SAND AND GRAVEL

144	Anderson-Cottonwood Concrete Products	Sec. 11, T 29 N, R 4 W, MDB&M	Anderson-Cottonwood Concrete Products, William Lane, Cottonwood (plant); James E. Music, Jr., First St., Cottonwood (pit)	Pit is in flood plain of Cottonwood Creek. Available sizes range from fine sand to 8 in., average about 3/8 in. Deposit moderately stratified in layers or lenses 8 in. to 3 ft. thick. Some sand and very minor clay lenses present, but there is no overall size gradation either vertically or laterally. 6 in. to 2 ft. of loam overburden are stripped before excavating gravel; material so obtained is stockpiled and sold locally. For test data and additional geological description, see Cottonwood Creek area, herein.	Just S of Cottonwood. Company began operations in July 1961. Crushing, screening, and washing plant averages 100 yds./hr.; concrete batching plant operates as jobs require. Water requirement of 3,500 gal./hr. is supplied by 125-ft. well. Shallow pit 1,000 ft. SE of plant is excavated by Michigan scoops and trucks. About 75 acres of material are available. Gravel is mined from above water table (i.e. stream level) during most of year; operations cease when high water floods pit. Some control over size of plant-feed gravel is obtained by selective excavating. Market area includes Red Bluff, Anderson, and points about 20 mi. E and W of Cottonwood. Company supplied batched concrete for Coleman Hatchery fish pens and Cottonwood General Elementary School in 1961–62. Products sold include aggregate, plaster sand, and loam.
	Anderson-Cottonwood Transit Mix, Inc.	Sec. 26, T 30 N, R 4 W, MDB&M	Anderson-Cottonwood Transit Mix, Inc., 1695 Barney, Anderson	.....	Company formed by Redding Transit Mix, Inc., which see, in March 1961. Noble batching plant about 1½ mi. SE of Anderson batches about 55 yds/hr. Concrete mix is transported to nearby jobs by trucks of Redding Transit Mix, which carry about 3 yds. each.
145	Anderson Creek.....	Sec. 22, T 30 N, R 4 W, MDB&M	Undetermined.....	Narrow stream-bed deposit. Contains pebbles and cobbles composed dominantly of metaconglomerate, quartz, and dark, fine-grained metasedimentary (?) rock; lesser amounts of greenstone, metarhyolite, granitic rock, sandstone, volcanic rock, and dacite tuff present. Sizes range from fine sand to 8 in., average ¼–1½ in.; 15% of material is 3–6 in. cobbles. Deposit exhibits only minor stratification. Occasional cemented strata and a small proportion of rotten particles are present. Little overburden.	About ½ mi. S of Anderson. Pit used by contractors for Cal. Div. Highways and by Shasta Co. Dept. Pub. Works since late 1940s. State had excavated 400,000 yds. by 1953. Worked by County in December 1962, using power shovel, bulldozer, trucks, and Cedarapids dry-crushing and -screening unit; some pit-run material used. Large pit 8–10 ft. deep has several hundred feet of face. Water not available at site. No commercial production. (U.S. Bur. Reclamation 38; Goldman 61:16.)
	Battle Creek.....	Sec. 6, T 29 N, R 2 W, & Secs. 1, 2, 3, T 29 N, R 3 W, MDB&M	Undetermined.....	Scattered gravelbars estimated to contain 200,000 yds. No overburden. Physical properties of gravel acceptable (1938 standards), but silt content high. Gravel consists chiefly of vesicular andesite, andesitic tuff, and lesser amounts of dacite and massive andesite.	About 10 mi. E of Cottonwood. Undeveloped. (U.S. Bur. Reclamation 38; Goldman 61:16.)
	Bob Blair Trucking.....	.....	Robert A. Blair, 4002 Alta Mesa Drive, Redding	.....	Principally an earth-transport business. Occassionally mines material from various pits, depending on location of job. Used Dodson pits, which see, during 1962.
	Boulder Creek.....	.....	.....	.....	See Churn Creek-Boulder Creek area, herein.
146	Carroll.....	Sec. 36, T 35 N, R 1 W, MDB&M	Rolla G. Carroll, Montgomery Creek	Loosely-consolidated, cross-bedded, pebbly, coarse sandstone of Eocene Montgomery Creek Fm. Tests (Cal. Div. Highways, 1958) show 1.1% moisture, sand equivalent 30, R value 79, and sizes as follows: Size — Percent pass 1 in. — 100 ¾ in. — 99 ⅜ in. — 99 4 mesh — 97 8 mesh — 92 16 mesh — 78 30 mesh — 50 50 mesh — 28 100 mesh — 18 200 mesh — 13	Just NW of Montgomery Creek. Pit active at least 10 years, crudely semi-circular pit face 300 ft. long, up to 60 ft. high. Bench face separates pit from large excavated area on E, 10 ft. lower than pit floor.
	Castle Creek.....	Secs. 15, 16, 21, T 38 N, R 4 W, MDB&M	Undetermined.....	Stream-bed deposit contains abundant cobbles and boulders, some up to 3 ft. across. Sand fraction contains quartz, feldspar, muscovite, biotite, hornblende, olivine, magnetite, and	NW of Castella. Considered by Cal. Div. Highways for freeway construction but probably not used.

SAND AND GRAVEL—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Castle Creek—Continued			small flakes of schist. Cobbles are subround to subangular, consist chiefly of granitic rock and amphibolite, with some serpentine. Tests (Cal. Div. Highways, 1953) show 0.3–0.9% moisture, sand equivalent 47–72, R value 76–84, specific gravities 2.79–2.96 (−4 mesh) and 2.76–2.77 (+4 mesh), unsatisfactory organic-impurity content, and LAR abrasion losses of 8.2% and 30.8% for 100 and 500 rev. Size analyses of 2 samples follow: Size — Percent pass 2 in. — 41–48 1½ in. — 35–41 1 in. — 30–34 ¾ in. — 26–29 ⅜ in. — 20–21 4 mesh — 16–15 8 mesh — 14–12 16 mesh — 11–8 30 mesh — 7–5 50 mesh — 4–5 100 mesh — 2–3 200 mesh — 2–2	
	Churn Creek-Boulder Creek area	Secs. 17, 18, 19, 20, T 32 N, R 4 W, MDB&M	Undetermined		Herein.
	Columbia Construction Company	Sec. 31, T 32 N, R 4 W, MDB&M			On W bank Sacramento River, in Redding. During the early and mid-1940s, this company excavated almost 12 million tons of sand and gravel for use in Shasta Dam. Material was excavated by 7- and 10-yd. draglines and power shovels; it was processed in a complex flow sheet involving a 7-in. jaw crusher, 4-ft. gyratory and cone crushers, a scrubber, an 8- by 11-ft. ball mill, several bowl and rake classifiers, wet screens, and an 8- by 12-ft. rod mill. Aggregate was moved about 9 mi. to the damsite by a system of belt conveyors, the longest in the world at that time. Gold was recovered using 8 rougher and 1 cleaner jigs and a revolving amalgamator; see also in placer gold section. The operation was discontinued upon completion of the dam; property later acquired by Redding Sand and Gravel, Inc., which see herein. (Tyler 45:100–101.)
	Cottonwood Creek	W½ T 29 N, R 3 W, E½ T 29 N, R 4 W, MDB&M	Undetermined		(U.S. Bur. Reclamation 38; Goldman 61:19; herein.)
	Crews		Undetermined		Philip Crews operated a small crushing and screening plant in the mid-1920s "on Sacramento River about 2 mi. E of Redding." (Logan 26:201.)
147	Crowe	Sec. 34, T 32 N, R 2 W, MDB&M	John Crowe, Millville	Post-Tuscan continental gravel possibly correlative with Red Bluff Fm. rests on Cretaceous Chico Fm. siltstone and sandstone. Pebbles and cobbles consist chiefly of pyroxene andesite and basalt; minor amounts of quartz and Chico siltstone are present. Gravel well rounded and generally flattish or elliptical in shape. Deposit is poorly consolidated, unstratified. Rotten particles (siltstone and andesite) comprise about 1% of gravel. Tests (Cal. Div. Highways, 1960–61) show 4.3–5.9% moisture, sand equivalent 21–37, R value 44–81, specific gravity 2.44 (+4 mesh) and 2.68 (−4 mesh); size ranges of 3 pit-run samples follow: Size — Percent pass 3 in. — 71–81 2½ in. — 60–75 2 in. — 50–66 1½ in. — 44–60 1 in. — 36–49 ¾ in. — 32–41 ⅜ in. — 26–31 4 mesh — 21–26 8 mesh — 15–22 16 mesh — 12–18 30 mesh — 9–14 50 mesh — 6–10 100 mesh — 5–8 200 mesh — 4–7	5½ mi. NE of Millville. Roughly rectangular pit 3–8 ft. deep has dimensions 250 by 300 ft.

SAND AND GRAVEL—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Diestelhorst	Sec. 25, T 32 N, R 5 W, MDB&M	Undetermined		On Sacramento River near present crossing of Highway 99. Charles Diestelhorst erected a gravel plant on S bank of Sacramento River in mid-1920s, built new plant on N bank in mid-1930s. Later operation employed a slack-line excavator and a plant with jaw and disc crushers, vibrating screens, and a sluice for recovering gold. The plant subsequently was dismantled around 1945. (Logan 26: 201; Averill 39:170.)
148	Dodson	Secs. 11, 12, T 30 N, R 4 W, MDB&M	Thomas B. Dodson, 1566 Pinion, Anderson	Gravel pit and sand pits are in old channel (?) or flood plain of Sacramento River. Gravel pit exposes gravelly sand with sizes ranging from clay to 6 in.; stratification is moderate, with layers 6 in. to 3 ft. thick. Layers of clayey sand are present. Pebbles and cobbles comprise 15% of deposit, consist chiefly of greenstone, andesite, basalt, dense fine-grained metamorphic rock, granitic rock, and serpentine. Sand pits expose friable sand of dominantly medium-grained size, in layers a few millimeters thick. Less than 5% of deposit consists of small pebbles; clayey sand layers are present locally.	2 mi. NE of Anderson. Sand pits are ¼ mi. E of gravel pit. Both are used intermittently by various operators who have small jobs requiring only pit-run material. Gravel pit is 6–12 ft. deep, 200 ft. in longest dimension. One of several small sand pits is 8 ft. deep, 40 ft. across. Both areas are above water table and are mined with front-end loaders and trucks.
	B. C. Foster, Inc.	Sec. 5, T 31 N, R 4 W, MDB&M (plant)	B. C. Foster, P.O. Box 624, Redding	Pit used in 1962 is on Stillwater Creek near Highway 44. For a discussion of the geology of gravel deposits in this vicinity see Stillwater Creek area.	Plant and office are in Enterprise; pit sites vary with the job. Portable dry screening plant has been in use 2 or 3 years, produces ¾- and 1½-in. sizes.
149	French Gulch	Sec. 14, T 33 N, R 7 W, MDB&M	Undetermined	Extensive accumulation of dredge tailings. Principal rock types are Bragdon metaconglomerate, Copley greenstone, quartz, schist, and dense, fine grained, siliceous metasedimentary rocks. Gravel is well rounded, somewhat flat in shape. Deposit is sand-deficient. Average size probably ½–2 in.; 10–15% of material is +3 in.; some boulders up to 1½ ft. across. Very few rotten particles are present.	One mi. N of French Gulch. Used by Shasta County Dept. Pub. Works for road construction and maintenance; material processed by portable crushing and screening plant. Stockpile of about 7,000 tons crushed, minus-1½-in. rock on property.
	Hat Creek-Pit River area	Secs. 12, 13, T 36 N, R 3 E, & Secs. 7, 17, 18, T 36 N, R 4 E, MDB&M	Undetermined		(U.S. Bur. Reclamation 38; herein.)
150	J. H. Hein Company	Sec. 6, T 31 N, R 4 W, MDB&M (plant); Sec. 7, T 31 N, R 4 W, MDB&M (pit)	Estelle P. Hein, 1930 Court St., Redding; pit leased from Henry Rother, 4000 Henderson Road, Redding		(Averill 39:170–171; O'Brien 48:361–362; 51:370 Goldman 61:26; herein.)
	J. R. Kettlewell		J. R. Kettlewell, 3130 Churn Creek Rd., Redding		A concrete batching plant formerly operated by Stuts-Crete Corp. at present site of Redding Sand and Gravel, Inc., was acquired by Kettlewell in May 1957. Its capacity was 250 yds./8 hrs. Kettlewell operated it intermittently until around 1960 to supply concrete aggregate for jobs on a contract basis. A second concrete batching plant, owned by J. H. Hein Co., was leased to Kettlewell as early as 1948. Gravel was obtained from J. H. Hein Co. Plant consisted of a 1,750-barrel cement silo, 4 sand and gravel bunkers, and weighing apparatus. 2 transit-mix trucks were used. Plant capacity was 200 yds./8 hrs. It was sold to Redding Transit Mix in May 1960 (O'Brien 48:362.)
	Lake Redding	Sec. 26, T 32 N, R 5 W, MDB&M	Undetermined	About ¼ sq. mi. of dredge tailings and terrace gravel. Tests in 1938 (U.S.B.R.) on nearby Benton tract indicated the presence of clay and rotten particles in deleterious amounts, and a deficiency in sand. Later tests (Cal. Div. Highways, 1948) on crushed dredge tailings show specific gravities of 2.80–2.82 (−4 mesh) and 2.72–2.74 (+4 mesh), 6.4–8.2% moisture, and abrasion losses of 3.4% and 17.8% (100 and 500 rev.).	N of Sacramento River and W of Lake Redding Park. Undeveloped. (U.S. Bur. Reclamation 38.)
	LaMoine-Pollard Flat area	Secs. 11, 15, T 36 N, R 5 W, MDB&M	U.S. Government, Southern Pacific Land Company et al.		Herein.
	Martin	Secs. 1, 2, T 38 N, R 4 W, MDB&M	Virgil Martin, Dunsmuir	Tightly packed cobbly gravel in terrace of Sacramento River. Rock types chiefly granitic, with basalt, ultrabasic rock, gabbro, andesite, diorite, and schist	About 1½ mi. S of Dunsmuir. Material used by Cal. Div. Highways in late 1950s, during construction of freeway S of Dunsmuir. Pit 15–25 ft. deep, 100 by 150 ft. in plan; now partly filled with large tree stumps and other debris.

SAND AND GRAVEL—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Martin—Continued			also present; sand fraction contains quartz, feldspars, hornblende, mica, magnetite, and pyrite. Little overburden. About 10% of material is +4 in. Tests (Cal. Div. Highways, 1958) show 0.6% moisture, R value 84–87, sand equivalent 39 (but 87 for washed sand), specific gravity 2.79 (−4 mesh) and 2.65 (+4 mesh), organic impurity content satisfactory, abrasion loss 9.6% and 35.8% (100 and 500 rev.), and sizes as follows: Size — Percent pass 3 in. — 68 2½ in. — 64 2 in. — 60 1½ in. — 57 1 in. — 52 ¾ in. — 49 ½ in. — 46 ⅜ in. — 43 4 mesh — 37 8 mesh — 30 16 mesh — 24 30 mesh — 17 50 mesh — 11 100 mesh — 7 200 mesh — 5	
	Millville-Palo Cedro area	T 31 N, R 3 W, MDB&M	Undetermined		(U.S. Bur. Reclamation 38; herein.)
	Morgan Construction Company	Sec. 19, T 32 N, R 4 W, MDB&M	Morgan Construction Company, P.O. Box 904, Redding		About 2 mi. NE of Redding. 2 small portable crushers are used infrequently, when job is distant from any commercial source of sand and gravel. Company leases a Madsen plant of 3,000 lbs. capacity from Oaks Sand and Gravel, which see; it mixes hot and cold bituminous aggregate to meet County and State specifications. The plant is at the Oaks plant site, and sand and gravel for it is obtained from them. In recent years, Morgan Construction Co. has provided asphalt paving for the Lewiston Fish Hatchery, the Calaveras Cement Co. plant near Redding, and College of the Siskiyous.
	Music				See Anderson-Cottonwood Concrete Products.
151	Oaks Sand and Gravel Company	Sec. 30, T 31 N, R 4 W, MDB&M (plant); Secs. 25, 26, T 31 N, R 5 W, MDB&M (pits)	Edward Oaks, 7140 Pit Road, Redding		(Logan 26:201; U.S. Bur. Reclamation 38; Averill 39:171; O'Brien 48:362–363; 51:370; Goldman 61:18; herein.)
152	Old Station	Sec. 8, T 32 N, R 5 E, MDB&M	U.S. Government	Fine, friable, pebbly, volcanic sand contains less than 1% of +1 in. material. Rock types include basalt, andesite, dacite, and pumice. Sand tends to be clayey in N part of pit. Tests (Cal. Div. Highways, 1958) show 0.6% moisture, R value 72–82, sand equivalent 67–92, specific gravity 2.30 (+4 mesh) and 2.63 (−4 mesh), and size ranges and averages (4 samples) as follows: Size — Percent pass range — aver. ⅜ in. — 98–100 — 99 4 mesh — 85–96 — 92 8 mesh — 67–86 — 79 16 mesh — 45–72 — 62 30 mesh — 31–57 — 46 50 mesh — 13–43 — 27 100 mesh — 3–25 — 13 200 mesh — 2–12 — 8	½ mi. SE of Old Station Post Office. Sand and gravel on placer claim held by C. M. Foster of Burney in 1958 was utilized by Cal. Div. Highways for imported borrow and road mixed surfacing. Pit 15 ft. deep, 70 by 150 ft. in plan. Idle.
	Palo Cedro				See Millville-Palo Cedro area, herein.
	Pit River				See Hat Creek-Pit River area, herein.
	Pollard Flat				See Lamoine-Pollard Flat area, herein.
153	Rayner	Sec. 25, T 37 N, R 1 W, MDB&M	F. E. Rayner, Jr., P.O. Box 307, Big Bend	Small bars in stream appear to have higher proportion of fines than do the shallow banks. Gravel is mostly subround, consists chiefly of basalt and andesite. Crushed rock has sand equivalent of 52.	On Kosk Creek, 1½ mi. NW of Big Bend. Used by Shasta County Dept. Pub. Works. Gravel obtained by dragline from stream bed and banks, processed in portable crushing and screening plant to yield minus-1½ in. material. 12,000 cu. yds. crushed in 1962, stockpiled on property.
	Redding Bar area	Sec. 31, T 31 N, R 5 W, & Sec. 36, T 31 N, R 6 W, MDB&M	Undetermined	Extensive area of dredge tailings north of Clear Creek. Principal rock types are granitic rock, greenstone, metarhyolite, metaconglomerate, and dense, fine gained metasedimentary rocks. In Sec. 36, boulders up to 3 ft.	½–1 mi. E of Redding Bar on Clear Creek. Used by Cal. Div. Highways in construction of new Clear Creek highway, 1957–58. Principal area worked is in NE¼ SE¼ Sec. 36. Large stockpile of minus-1-in. material here was processed by Shasta County Dept. Pub. Works in 1961 or 1962.

SAND AND GRAVEL—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Redding Bar area —Continued			across are present; deposit contains 2% plus-1-ft. material, and 10% plus 6 in. Tests (Cal. Div. Highways, 1954 & 1956) show 0.3–0.4% moisture, R value 67–80, sand equivalent 60 (Sec. 36) and 11–20 (Sec. 31), specific gravity 2.61 (+4 mesh) and 2.74 (−4 mesh), abrasion loss 5.8–11.0% and 26.6–36.8% (100 and 500 rev.), and sizes as follows (Sec. 36 only): Size — Percent pass 1½ in. — 52 1 in. — 30 ¾ in. — 21 ⅜ in. — 5 4 mesh — 2 8 mesh — 2	
154	Redding Sand and Gravel, Inc.	Sec. 31, T 32 N, R 4 W, MDB&M	Frances Kutras, East Butte St., Redding; leased to Redding Sand and Gravel, Inc., M. W. Brown, Pres.	.....	(U.S. Bur. Reclamation 38; Goldman 61:26; herein.)
155	Redding Transit Mix, Inc...	Sec. 6, T 31 N, R 4 W, MDB&M	Redding Transit Mix, Inc., 2511 Henderson Rd., Redding; L. T. Stinnett, Pres.	.....	S of Highway 44 bridge over Sacramento River. Company incorporated April 1960 with Edmund H. Shea, L. T. Stinnett, and others as directors. Company acquires all aggregate from J. F. Shea Co., Inc., about 6½ mi. distant by road (see Shea, herein). Aggregate from Shea is already sized, but sometimes is rescreened. A concrete batching plant, purchased from J. H. Kettlewell in May 1960, has a capacity of about 600 yds./8 hours. Maximum water requirement of plant is 3,000 gal./hour; water is supplied by well, contains 62 ppm total dissolved solids, 42 ppm NaCl. Company sells bulk ready-mixed concrete and certain specialty items in a market area normally confined to Shasta County; recent jobs include U.S. Highway 99 bridge over Sacramento River, Spring Creek debris dam, new addition to Mercy Hospital, and buildings of Village Plaza shopping center. See also Anderson-Cottonwood Transit Mix, Inc.
156	Riley Trucking.....	Sec. 18, T 32 N, R 4 W, MDB&M	Charles Riley, Jr., P.O. Box 717, Redding	Material obtained from gravel bar about 200 ft. long and from pit 4–10 ft. deep with several hundred feet of face, in flood-plain deposit adjacent to stream. Flood-plain material is unstratified and contains pebbles and cobbles up to 12 in. diameter in a reddish matrix of clay, silt, and sand; dominant particle size is ⅛–1 in., and about 30% of material is sand size or less. Rock types include greenstone, andesite, basalt, metaconglomerate, diorite, quartz, metarhyolite, and sandstone. Some replenishment at flood stage. Little overburden. A widespread clay layer forms the bottom of the pit.	On Churn Creek, about 3 mi. NNE of Redding. Company formed July 1957. Prior to 1959, material was excavated by dragline and sold principally as pit-run for common fill or road base; a small amount was hauled ¼ mi. N to a small crushing and screening plant where minus-¾-in. material was washed for use as concrete aggregate. In recent years, this plant was abandoned and a portable unit is used instead. Deliveries are made in 6-yd. dump trucks. See also Churn Creek-Boulder Creek area, herein. (Goldman 61:18.)
	Sacramento River.....	.....	.....	.....	See LaMoine-Pollard Flat area, herein, and Sims area.
157	J. F. Shea Co., Inc.....	Sec. 30, T 31 N, R 4 W, MDB&M	J. F. Shea Co., Inc., 1290 Smith Rd., Redding	.....	(Goldman 61:27; herein.)
	Sims area.....	Secs. 17, 18, 19, T 37 N, R 4 W, MDB&M	U.S. Government, E. M. Herron et al.	Streambed and low terrace gravels. Large boulders prominent in all terraces. Principal rock types include gabbro, granitic rock, amphibolite, andesite, serpentine, and metasandstone; sand fraction includes quartz, feldspar, hornblende, chlorite, olivine, biotite, and magnetite. Deposits were estimated to contain several hundred thousand tons of usable material. Tests (Cal. Div. Highways, 1953, 1955) show 0.3–3.2% moisture, R value 77–87, sand equivalent 61–69, specific gravities 2.83–2.88 (−4 mesh) and 2.63–2.76 (+4 mesh), abrasion loss 5.2–6.2% amd 23.2–	3 deposits along Sacramento River, ¾–2 mi. SW of Sims. Deposits active 1961–63. In December 1962, hot-mix plant and crushing and screening plant were being operated by E. C. Hall Co. in Sec. 19; material produced was used in freeway construction along Highway 99. Southerly of 2 prominent terraces in Sec. 19 was largely worked out and portable crushing and screening plant had been dismantled by end of 1962; pit floor was within 0–4 ft. of river level.

SAND AND GRAVEL—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Sims area—Continued			24.0% (100 and 500 rev.), and sizes as follows: Size — Percent pass Sec. 19 — Sec. 17 2 in. — — 55 1½ in. — 59 — 51 1 in. — 50 — 44 ¾ in. — 44 — 41 ⅜ in. — 35 — 32 4 mesh — 26 — 22 8 mesh — 19 — 14 16 mesh — 13 — 7 30 mesh — 7 — 4 50 mesh — 4 — 3 100 mesh — 3 — 2 200 mesh — 3 — 1	
	Stillwater Creek area	Secs. 2, 11, 14, 26, 35, T 31 N, R 4 W, MDB&M	C. D. Miller, R. A. Cockerill, L. Ingraham, City of Redding et al.	Floodplain gravel occupies old stream-channel cut in Red Bluff Fm. Channel about 1500 ft. wide, largely soil covered, at Hwy. 44; narrows to 1200 ft. (no overburden) 1 mi. downstream, 1000 ft. ½ mi. farther at Shasta Co. pit, 800 ft. opposite municipal airport. Few cobbles or boulders. U.S. Bur. Reclamation (1938) reports deposit contains "considerable amount" greenstone and slate, "high percentage" deleterious sandstone, shale, and conglomerate, small percentage dacite tuff and lavas. Proportion of quartz in sand relatively high. Grab sample in SW4 Sec. 14 had losses in sodium-sulfate soundness tests of 14.7% (sand) and 31.2% (gravel), attributed to sandstone and slate (U.S. Bur. Reclamation, 1938). Sieve analysis of minus-2-in. road base material follows: Size — Percent pass 2 in. — 100 1½ in. — 99 1 in. — 91 ¾ in. — 83 ⅜ in. — 62 4 mesh — 44 8 mesh — 35 30 mesh — 16 50 mesh — 11 100 mesh — 6 200 mesh — 4	Gravel utilized by private contractors and public agencies. Principal production from 3 areas: 200- by 400-ft. area in SE¼ SW¼ Sec. 11 (State Div. Highways); 500- by 500-ft. area in center W½ W½ Sec. 14 (Shasta County); and 600- by 3,500-ft. area in SE¼ Sec. 26 and NE¼ NE¼ Sec. 35 (City of Redding). County pit had several thousand tons of material stockpiled in 1963. (U.S. Bur. Reclamation 38; Goldman 61:31.)
	Stuts-Crete Corporation	Secs. 20, 31, T 32 N, R 4 W, MDB&M	E. H. Quimet, P.O. Box 566, Redding	For geological descriptions, see Churn Creek-Boulder Creek area and Redding Sand and Gravel, Inc., herein.	Active 1950s, disbanded April 1957. Excavated gravel from Churn Creek bottom for use as road fill and driveway gravel. Plant was moved to site of Redding Sand and Gravel, Inc. in January 1955. Batching plant acquired by J. R. Kettlewell, which see, in May 1957.
	Sugarloaf Peak	Sec. 11, T 33 N, R 4 E, MDB&M	Undetermined	Several acres of poorly-stratified, well rounded, volcanic sand and gravel. Maximum size of gravel about 4 in., average less than ½ in.; sand with little clay comprises about 90% of deposit. No overburden.	5 mi. N of Old Station. Several pits of various dimensions. Equipment on property in December 1962 included 2 small front-end loaders and a ½-yd. dragline. Large stockpiles of graded sand and gravel comprise several thousand tons.

STONE—CRUSHED

158	Bagula	Sec. 13, T 33 N, R 2 W, MDB&M	Floyd T. Bagula, Oak Run	Quarry is in upper part of 150-ft.-thick Pliocene (?) basalt flow that overlies Cretaceous sediments of Chico Fm. Most of pit face exposes an unusually slabby, dark gray, porphyritic, pyroxene basalt; some massive basalt at E end of pit. Slabs commonly ½–1 in. thick, ½–1 ft. across. Almost all slabs have thin skin of durable weathered material that is pale buff to light red in color.	On Bullskin Ridge, 2½ mi. N of Oak Run. Used by Shasta County Dept. Pub. Works for several years. Pit 8 ft. deep has sinuous face about 250 ft. long. Material processed by portable crushing and screening plant. Small stockpile of minus-1½-in. rock on property.
	Bishop	Sec. 24, T 35 N, R 1 E, MDB&M	Fuller Estate; address undetermined	Broken fragments of basalt in a matrix of deep red soil exposed in pit. Tests (Cal. Div. Highways, 1952) on quarried rock show 3.6% moisture, sand	About 6 mi. E of Montgomery Creek. Rock quarried in 1941 for use in road construction between Hillcrest and Big Bend; may have been used in mid-1950s during realigning of Highway 299. Small pit with 15-ft. face 60 ft. long; part of former pit

STONE—CRUSHED—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Bishop—Continued			equivalent 23, R value 79, and sizes as follows: Size — Percent pass 3 in. — 95 2½ in. — 91 2 in. — 79 1½ in. — 70 1 in. — 60 ¾ in. — 52 ⅜ in. — 41 4 mesh — 33 8 mesh — 26 16 mesh — 21 30 mesh — 18 50 mesh — 15 100 mesh — 13 200 mesh — 12	may have been partially covered by present highway. Long idle.
159	Dubois	Sec. 36, T 34 N, R 2 W, MDB&M	P. E. Dubois, Bella Vista	Slopewash, soil, and broken rock 8–30 ft. thick overlying bedrock. Rock types present include "shale", graphitic slate, greenschist, and massive greenstone of Triassic Pit Fm. Tests (Cal. Div. Highways, 1960) show 6.0–9.0% moisture, sand equivalent 25–34, R value 54–82, and size ranges as follows: Size — Percent pass ¾ in. — 100 ⅜ in. — 80–91 4 mesh — 52–70 8 mesh — 36–50 16 mesh — 29–37 30 mesh — 24–28 50 mesh — 20–23 100 mesh — 17–20 200 mesh — 15–18	3 mi. NE of Ingot. Used by Cal. Div. Highways in 1960s; active January 1963. "Pits" consist of several areas in which loose rock has been scalped from underlying bedrock; faces are 60 ft. high, 80–100 ft. wide. Material is used as is for repair of road base and shoulders.
160	Fern	Sec. 24, T 33 N, R 1 W, MDB&M	Undetermined	Slabby, fractured, bluish-gray andesite contains 5% of somewhat-oriented phenocrysts of plagioclase and sparse hornblende up to 4 mm. long. Slabs average 1 in. thick, 2–3 in. across; break easily.	4½ mi. N of Whitmore. Used by Shasta County Dept. Pub. Works. Pit 6–12 ft. deep, about 125 by 200 ft. in plan.
	Fuller Flat	Sec. 26, T 35 N, R 1 E, MDB&M	Undetermined	Flow of brittle, thoroughly-fractured, dark green and purple basalt contains 2–5% small plagioclase phenocrysts in aphanitic groundmass. Rock breaks easily to angular rubble with less than 10% of pieces more than 1 ft. across.	Adjacent to Highway 299, 5½ mi. NE of Montgomery Creek. Asymmetrically-shaped pit has face 70 ft. high, 300 ft. long. Probably used to supply road-base material for highway. Inactive in recent years.
161	Grant	Sec. 34, T 34 N, R 1 W, MDB&M	Undetermined	Massive but finely-fractured, bluish-gray, porphyritic biotite andesite is capped locally by up to 10 ft. of mudflow debris composed of the same material. Tests (Cal. Div. Highways, 1945) on "cemented volcanic sand" show specific gravity of 2.59 (−4 mesh) and sizes as follows: Size — Percent pass 4 mesh — 100 8 mesh — 74 16 mesh — 48 30 mesh — 34 50 mesh — 23 100 mesh — 15 200 mesh — 9 270 mesh — 8	3 mi. SW of Round Mountain townsite. Small, semicircular pit has face 25 ft. high, 60 ft. in diameter. Long idle.
	Kenyon	Sec. 11, T 36 N, R 5 W, MDB&M	W. C. & C. E. Kenyon, Salinas	Large, broken, metamorphic rock fragments tightly compacted with minor matrix of "fines" (i.e. −1½ in.) and soil. Existing railroad cut shows fragmented rock in place, with some fragments up to 15 ft. across. Tests on fines (Cal. Div. Highways, 1953) show 0.4% moisture, sand equivalent 58, R value 72–80, and specific gravity (+ 4 mesh) 2.74; tests on rock crushed to −¾ in. show specific gravity 2.79 (+ 4 mesh) and 2.89 (−4 mesh), and abrasion loss of 3.0% and 12.2% (100 and 500 rev.).	Adjacent to Sacramento River, 1¼ mi. NE of Lamoine. Considered as road base and surfacing material for Highway 99 realignment, but probably not used.

STONE—CRUSHED—Continued

Map No.	Name of claim, mine, or group	Location	Owner (Name, address)	Geology	Remarks and references
	Moore	Sec. 3, T 29 N, R 10 W, MDB&M	Adele Moore, Santa Rosa.	Dump material from Midas gold mine, which see in gold section herein, consists chiefly of greenschist and quartz. More than 100,000 tons reportedly available.	At Knob, 5 mi. NW of Platina. Used by Cal. Div. Highways for road maintenance. 2,957 tons used by mid-1962.
162	P.G.E.	Sec. 36, T 37 N, R 4 E, MDB&M	Pacific Gas & Electric Company, 245 Market St., San Francisco	Pliocene(?) flow of light gray olivine basalt with minor oyroxene; massive except for uppermost 3 ft., which are very scoriaceous. Up to 2 ft. of deep red, clayey soil overburden. Tests on rock crushed to −1½ in. (Cal. Div. Highways, 1946) show specific gravity 3.00 (−4 mesh) and 2.72 (+4 mesh), abrasion loss 6.6% and 33.6% (100 and 500 rev.), and 2.1% absorption; crushing to −1½ in. yielded 40% −4 mesh, 12% −100 mesh, and 7% −270 mesh.	1 mi. W of Fall River Mills. Used by Cal. Div. Highways for road surfacing. Pit has semi-circular face 12–20 ft. high, 150 ft. long. Rock was quarried by drilling with shallow 1½-in. holes, blasting with low-fragmenting powder. Idle for several years.
163	Shasta Forests Company	Sec. 36, T 39 N, R 2 E, MDB&M		Pit debris consists of subangular fragments of vesicular, dark gray basalt. Deeply weathered flows in place are exposed on E side of pit; rock breaks easily to fragments of average size ½–1½ in., with material more than 8 in. across rare. Deep red, clayey soil occurs on flows and in fractures in flows.	10 mi. N of Burney Falls. Used by Cal. Div. Highways in 1962 for road base and maintenance material. Pit 15 ft. deep, 200 by 300 ft. in plan.
	Spring Creek Tunnel	Sec. 13, T 32 N, R 6 W, MDB&M	Undetermined	Large dump of granitic rock resulting from driving tunnel.	2 mi. N of Shasta. Acquired by County in 1962.

STONE—DIMENSION

	Elliott	Sec. 34, T 35 N, R 5 W, MDB&M	U.S. Government; F. C. Elliott, Central Valley, lessee	Layers 15 ft. thick of thin bedded shaly tuff are interbedded with firmly cemented sandstone and metavolcanic rocks. The tuff contains narrow bands in a wide range of contrasting colors.	On W shore Lake Shasta, about 5 mi. SW of Lakehead. Broken material has been removed from a roadcut; it is cut, polished, and sold locally as decorative pieces.
164	Jewel	Sec. 25, T 31 N, R 6 W, MDB&M	Undetermined	Massive, light gray, even-grained biotite quartz diorite.	2½ mi. E of Igo. Active prior to 1906; rock used to limited extent in Redding for tombstones, street curbing, and doorsteps. Small quarry. Long idle. (Aubury 06:53; Diller 06:14; Brown 16:804.)
	Masterson Bros.	Sec. 20, T 32 N, R 6 W, MDB&M	Undetermined	Massive boulders of granitic rock (trondhjemite?).	1½ mi. S of Stella. Boulders were worked prior to 1906 and used locally for curbing and coping. Long idle. (Aubury 06:53; Brown 16:804.)
165	Millville	Sec. 18, T 31 N, R 2 W, MDB&M	Undetermined	Light- to medium-gray welded tuff. Contains clasts of white and dark pumice, and small fragments of dacite and andesite. Rock moderately soft, hardens on exposure to air.	2½ mi. E of Millville. Active 1860s to around 1915, but essentially idle by 1896. Quarry face 30–50 ft. high. Rock used in Millville and vicinity for chimneys, fireplaces, water coolers, and small outbuildings; a church at Millville was made of this rock in 1868, but is no longer standing. (Diller 04:179; Aubury 06:161; Brown 16:808.)
166	Texas Spring	Sec. 29, T 31 N, R 5 W, MDB&M	Undetermined	Massive, fine grained, greenish-gray Cretaceous graywacke with prominent biotite flakes about 1 mm. across. Thick beds dip gently SE. Contains concretions and some thin lenses carrying fossils.	5½ mi. SW of Redding. First active 1894 or 1895. In 1895, pit size was 16x50x7 ft.; 13 men were employed and weekly production was 250 cu. ft. of finished rock. Used locally for railroad culverts and trimming on buildings. Rock in low wall around County Courthouse grounds came from here. Idle since around 1903. (Crawford 96:637; Aubury 06:138–139; Diller 96:14.)

SULFUR

	Iron Mountain	Sec. 26, 27, 33, 34, 35, 36, T 33 N, R 6 W, MDB&M	The Mountain Copper Company, 100 Mococo Road, Martinez		For many years, pyrite was mined for its sulfur content. See herein under pyrite. For extended list of references see tabulated list under copper; for additional description see herein under copper, gold, and iron.
	Supan Sulphur Works	Sec. 21, T 30 N, R 4 E, MDB&M	U.S. Government	Sublimated crusts and impregnations of sulfur deposited from gases and active hot springs.	In Lassen Volcanic National Park. Located 1865, patented 1920s. Acquired 1951 by U.S. Government. Small production prior to 1900. (Averill 39:173; Lydon 57:616.)

TALC

167	Ganim	Sec. 5, 8, T 32 N, R 6 W, MDB&M	Ganim Gold Mining Company, Wm. G. Thompson, Secretary, Redding		(Tucker 22:730–731; 23:11; Logan 24:15; 26:171–172; 210–211; Averill 33:26–27; 39:173–174; O'Brien 43:82; Page and Wright 43; Albers 65:33; herein.)

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CALIFORNIA DIVISION OF MINES AND GEOLOGY
WESLEY G. BRUER, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SHASTA

Eastern Klamath Belt

Paleozoic and Triassic Rocks

Central Metamorphic Belt

Paleozoic Belt

Northern Sierra Nevada Batholith

Jurassic Eastern Shasta County Belt

CASCADE RANGE

GREAT VALLEY

MODOC PLATEAU

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SHASTA COUNTY REPORT 6
PLATE 1

EXPLANATION

Qrv — Volcanic rocks
Intrusive dacite domes, flows of basalt, and pyroclastic deposits.

QP — Nonmarine sedimentary and unconsolidated deposits
Tehama and Red Bluff Formations; glacial, lake, and river-terrace deposits; alluvium; and dredge tailings.

TQv — Volcanic rocks
Tuscan Formation; Nomlaki Tuff Member of Tuscan and Tehama Formations; cinder cones; andesitic and basaltic flows and small intrusive masses; and minor pyroclastic deposits.

Ec — Montgomery Creek Formation
Nonmarine sedimentary rocks.

K — Marine sedimentary rocks
Chico Formation and other units.

gr — Granitic rocks
Quartz diorite of Shasta Bally batholith, trondhjemite of Mule Mountain stock, mafic quartz diorite of McCloud River area, granodiorite of Castle Crags, and other scattered occurrences.

ub — Ultrabasic and basic intrusive rocks
Mostly serpentinized peridotite, with subordinate dunite, pyroxenite.

JT — Metamorphosed volcanic and sedimentary rocks
Bully Hill Rhyolite, Pit Formation, Hosselkus Limestone, Brock Shale, Modin, Arvison, and Potem Formations, and Bagley Andesite.

M — Bragdon Formation
Metamorphosed marine sedimentary rocks.

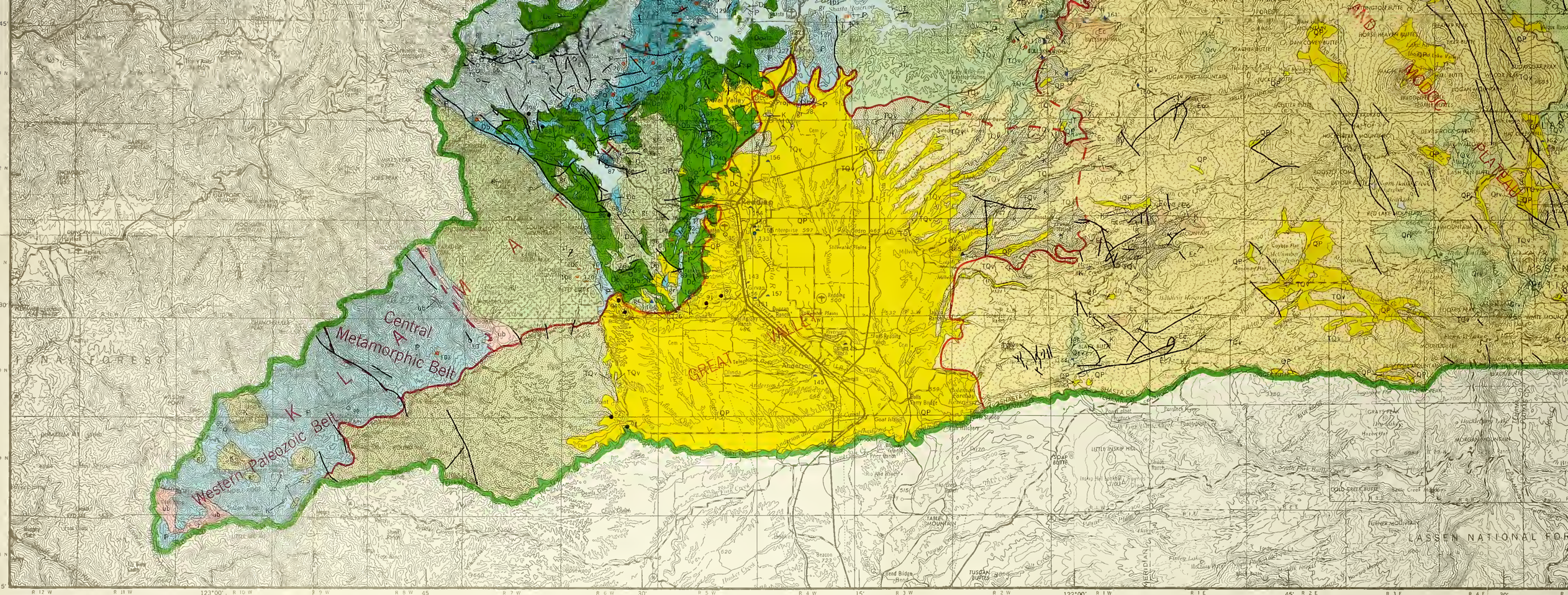
Db — Balaklala Rhyolite
Metamorphosed siliceic volcanic flows and pyroclastic deposits.

Dc — Copley Greenstone
Metamorphosed siliceic volcanic flows and pyroclastic deposits.

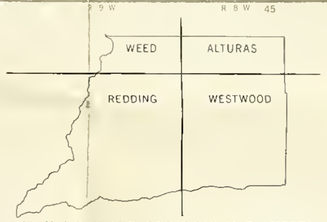
P — Combined geologic units
Salman and Abrams Formations; Grouse Ridge, Stuart Fork, and Chanchelulla Formations; Kennett and Baird Formations; McCloud Limestone; and Nosoni and Dekkas Formations; some of indefinite age.

CENOZOIC — QUATERNARY — Holocene
CENOZOIC — CRETACEOUS — Eocene
MESOZOIC — TRIASSIC – JURASSIC
PALEOZOIC — MISSISSIPPIAN
PALEOZOIC — MIDDLE [?] DEVONIAN
PALEOZOIC — UNDIFFERENTIATED

INDEX MAP



TOPOGRAPHIC BASE MAP BY THE U.S. GEOLOGICAL SURVEY



INDEX TO STATE GEOLOGIC MAP SHEETS
COVERING SHASTA COUNTY

Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS

CARTOGRAPHY DRAFTED BY EDWARD L. FOSTER

GEOLOGY ADAPTED FROM GEOLOGIC MAP OF CALIFORNIA, OLAF P. JENKINS EDITION – ALT
AND QUINTIN A. AUNE 1958), REDDING SHEET (COMPILED BY RUDOLPH G. STRAND 1962)
STRAND 1963) AND WESTWOOD SHEET (COMPILED BY P. A. LYDON, T. E. GAY, JR., AND C.

GEOLOGIC MAP OF SHASTA COUNTY, CALIFORNIA

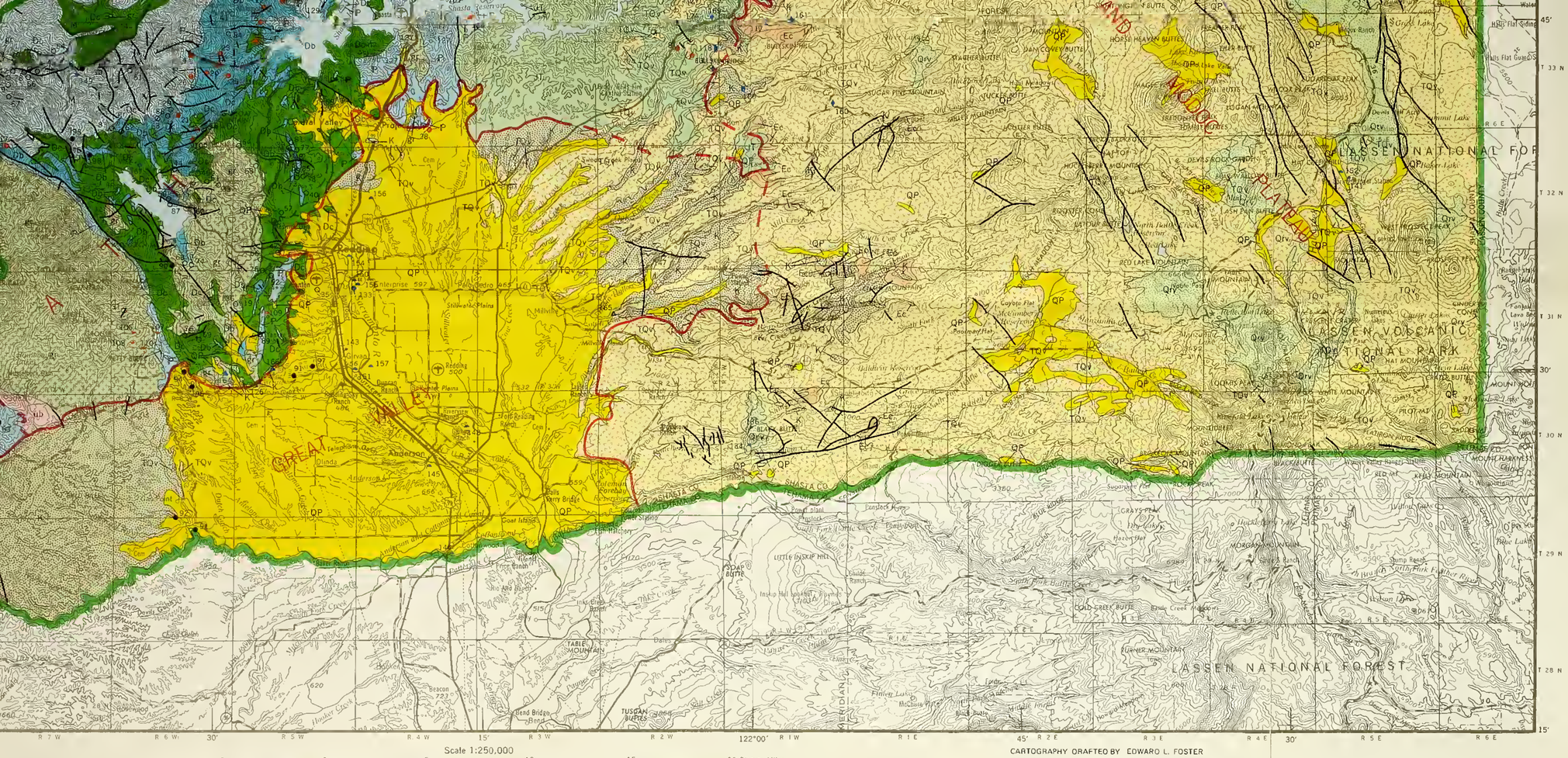
SHOWING MINES AND MINERAL DEPOSITS

by Philip A. Lydon 1972

MINES AND MINERAL DEPOSITS

PRINCIPAL OR RECENTLY ACTIVE MINES

Map No.	Name of property	Location Sec.	T.	R.
	CHROME			
1	Castella Mining and Milling Company	16	38N	4W
2	Davis group	24	37N	5W
3	Forest Queen	22, 27	37N	5W
4	Little Castle Creek	2	38N	4W
5	Lucky Strike	7	38N	4W
6	Prim and Dougherty	13, 24	37N	5W
7	Round Bottom	5	28N	10W
	COPPER			
8	Afterthought	10, 11, 15	33N	2W
9	Akers group	6, 7	33N	5W
10	Balaklala group	11, 12, 13, 14	33N	6W
11	Baxter-Winthrop	21, 28	34N	3W
12	Bully Hill-Rising Star	15, 16, 21, 22, 28	34N	3W
13	Donkey	11	33N	2W
14	Early Bird	10, 11	33N	6W
15	Friday-Louden	5, 6	33N	5W
16	Golinsky	28	34N	5W
17	Greenhorn	5, 6	32N	7W
		31, 32	33N	7W
18	Iron Mountain	26, 27, 33, 34, 35, 36	33N	6W
19	JCL	8	31N	5W
20	Keystone	13, 14	33N	6W
21	Lone Star	27	33N	6W
22	Mammoth	32	34N	5W
23	Shasta King	11, 12	33N	6W
24	Shasta May Blossom	14, 15	34N	3W
25	Spread Eagle group	13	33N	6W
26	Stowell	14	33N	6W
27	Sutro	29, 30	34N	5W
28	Thompson	34	33N	4W
	GOLD, LODE			
29	Ajax	28	33N	6W
30	American	12, 13	33N	7W
		7	33N	6W
31	Ballou	7, 18	31N	6W
32	Bell Cow	35	30N	9W
33	Benson group	12, 14	32N	6W
34	Bjork group	6	33N	6W
35	Blue Gravel	2	31N	5W
36	Boswell group	7	31N	5W
37	Buena Vista	5	31N	5W
38	Calumet Consolidated	10	32N	5W
39	Central	3, 4	32N	5W
		33, 34	33N	5W
40	Cleveland	15	32N	5W
41	Clipper and Snyder group	31	34N	5W
		36	34N	6W
42	Combination	17	33N	7W
		1	33N	6W
43	Delta Consolidated	6	35N	5W
		31	36N	5W
44	Desmond	9	32N	6W
45	Eiller	11	32N	6W
46	El Dorado	3	32N	7W
47	Eureka Tellurium	29	32N	5W
48	Evening Star	3, 4	32N	5W
49	Franklin and Milkmaid	8, 9, 16, 17	33N	7W
50	Gambrinus	16	32N	6W
51	Gladstone	7, 8, 17, 18	33N	6W
52	Gold Leaf	5	31N	5W
53	Green	5	30N	7W
54	Highland	9, 10	33N	7W
55	Highland Lake	12	37N	6W
56	Hoboe	17	33N	7W
57	Hummingbird	21	32N	5W
58	Jealous	6	32N	5W
59	Jumbo	23	31N	6W
60	Kanaka	15	32N	6W
61	Lady Slipper	11	32N	6W
62	Mad Mule	31	33N	6W
	GOLD, LODE—Continued			
63	Mad Ox	28	33N	6W
64	Menzel	31	33N	5W
		6	32N	5W
65	Midas	3, 4, 10	29N	10W
66	Milton	31, 32	32N	5W
67	Miners' group	19	33N	7W
68	Mount Shasta	34	32N	6W
69	National	23	33N	5W
70	Niagara	7, 8, 17, 18	33N	7W
71	Old Indian	4	33N	2W
72	Old Spanish	31	32N	5W
73	Original Quartz Hill	10, 11, 15	32N	5W
74	Oro Fino	34, 35	32N	6W
75	Oro Grande	5	31N	5W
76	Potosi	15, 22	31N	6W
77	Reid	3, 4	32N	5W
		34	33N	5W
78	St. Jude	17	33N	7W
79	Summit	19	33N	7W
80	Sybil	7	33N	7W
81	Texas Consolidated	4	32N	5W
		32, 33	33N	5W
82	Tom Green	18	33N	7W
83	Trusecott	36	33N	7W
84	Uncle Sam	1	33N	6W
		6	33N	5W
85	Walker	3, 4	32N	5W
86	Washington	16, 17	33N	7W
87	West End	16	32N	6W
88	Whiskey Hill	28	33N	6W
89	Yankee John	17	31N	5W
	GOLD, PLACER			
90	B.H.K. Mining Company	34	32N	6W
91	Clear Creek Dredging Company	2	29N	6W
		28	31N	5W
92	Crow Creek Dredging Company	33	30N	6W
93	French Gulch Dredging Company	11, 14	33N	7W
94	Hardscrabble	27, 34, 35, 36	31N	6W
	GOLD, PLACER—Continued			
95	Lincoln Gold Dredging Company	34	33N	7W
96	Russell	34	31N	6W
97	Thurman Gold Dredging Company	26, 27	31N	5W
98	Tripp	2	32N	7W
	IRON			
99	Hirz Mountain	7, 8	35N	3W
100	Iron Mountain	34	33N	6W
101	Shasta Iron Company group	26	34N	4W
	LEAD			
102	Silver Fern	29	34N	1W
	MANGANESE			
103	Negro Hill	14	30N	8W
104	Pit River Consolidated	1	33N	4W
		36	34N	4W
	MOLYBDENUM			
105	Boulder Creek	33	37N	5W
	SILVER			
106	Big Dyke	18, 19	31N	6W
107	Climax	16, 21	31N	6W
108	Silver Falls-Chicago Consolidated	17, 18, 19, 20	31N	6W
109	Silver King	8	31N	5W
110	White Star	20	31N	6W
	ASBESTOS			
111	Blas group	20	37N	5W
112	Stock	1, 2, 4, 12	37N	5W
		33	38N	5W
113	Sylvester	1	37N	5W
	BARITE			
114	Afterthought	2	34N	4W
115	Glidden	18, 19	38N	3W
116	Hirz Mountain	12	35N	4W
	COAL			
117	Barnes	4	33N	1W
118	Dakin	12	33N	2W
119	Kosk Creek	22	38N	1E
120	Luce	20	33N	1W
	DIATOMITE			
121	Cayton Creek group	17, 18, 19	37N	3E
122	Insulator group	19, 30, 31	37N	4E
		21, 22, 23, 24, 25, 26, 27, 36	37N	3E
		1, 12	36N	3E
		7	36N	4E
123	Sheep Springs	26, 35	37N	2E
	LIMESTONE			
124	Asher	1, 2	33N	2W
125	Briggsville	31	31N	5W
126	Brock Mountain	8	34N	2W
127	Calaveras Cement Company	2, 3, 9, 16	33N	4W
128	Emerald Glen	1	33N	2W
		6	33N	1W
129	Holt and Gregg	34	34N	5W
130	Shasta Iron Company	26	34N	4W
	MINERAL SPRINGS			
131	Big Bend Hot Springs	36	37N	1W
132	Castle Crag Spring	11, 12	38N	4W
133	Mountain Spring Water Company	6	31N	4W
	PUMICE, ETC.			
134	Black Butte	17	30N	1W
135	Doyle Butte	31	35N	4E
		6	34N	4E
136	Haeckler	8	30N	1W
137	Horr	21	38N	4E
138	Maacooatche	9	34N	4E
139	Perk-O-Lite	23	36N	5E
140	Pit No. 1	35	37N	4E
		11	36N	4E
	PUMICE, ETC.—Continued			
141	Potato Butte			
142	Sanford			
143	Stewart Masonry Supply			
	SAND AND GRAVEL			
144	Anderson-Cottonwood Co Products			
145	Anderson Creek			
146	Carroll			
147	Crowe			
148	Dodson			
149	French Gulch			
150	J. H. Hein Company			
151	Oaks Sand and Gravel Co			
152	Old Station			
153	Rayner			
154	Redding Sand and Gravel			
155	Redding Transit Mix, Inc			
156	Riley Trucking			
157	J. F. Shea Company, Inc			
	STONE, CRUSHED			
158	Baguia			
159	Dubois			
160	Fern			
161	Grant			
162	P. G. E.			
163	Shasta Forests Company			
	STONE, DIMENSION			
164	Jewel			
165	Millville			
166	Texas Spring			
	TALC			
167	Ganim			



GEOLOGIC MAP OF SHASTA COUNTY, CALIFORNIA

SHOWING MINES AND MINERAL DEPOSITS

by Philip A. Lydon 1972

Map No.	Name of property	Location Sec.	T.	R.
	GOLD, LODE—Continued			
63	Mad Ox	28	33N	6W
64	Menzel	31	33N	5W
		6	32N	5W
65	Midas	3, 4, 10	29N	10W
66	Milton	31, 32	32N	3W
67	Miners' group	19	33N	7W
68	Mount Shasta	34	32N	6W
69	National	23	33N	5W
70	Niagara	7, 8, 17, 18	33N	7W
71	Old Indian	4	33N	2W
72	Old Spanish	31	32N	5W
73	Original Quartz Hill	10, 11, 15	32N	5W
74	Oro Fino	34, 35	32N	6W
75	Oro Grande	5	31N	5W
76	Potosi	15, 22	31N	6W
77	Reid	3, 4	32N	5W
		34	33N	5W
78	St. Jude	17	33N	7W
79	Summit	19	33N	7W
80	Sybil	7	33N	7W
81	Texas Consolidated	4	32N	5W
		32, 33	33N	5W
82	Tom Green	18	33N	7W
83	Truscott	36	33N	7W
84	Uncle Sam	1	33N	6W
		6	33N	5W
85	Walker	3, 4	32N	5W
86	Washington	16, 17	33N	7W
87	West End	16	32N	6W
88	Whiskey Hill	28	33N	6W
89	Yankee John	17	31N	5W
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96	Russell	34	31N	6W
97	Thurman Gold Dredging Company	26, 27	31N	5W
98	Tripp	2	32N	7W
	IRON			
99	Hirz Mountain	7, 8	35N	3W
100	Iron Mountain	34	33N	6W
101	Shasta Iron Company group	26	34N	4W
	LEAD			
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	MANGANESE			
103	Negro Hill	14	30N	8W
104	Pit River Consolidated	1	33N	4W
		36	34N	4W
	MOLYBDENUM			
105	Boulder Creek	33	37N	5W
	SILVER			
106	Big Dyke	18, 19	31N	6W
107	Climax	16, 21	31N	6W
108	Silver Falls-Chicago Consolidated	17, 18, 19, 20	31N	6W
109	Silver King	8	31N	5W
110	White Star	20	31N	6W
	ASBESTOS			
111	Blas group	20	37N	5W
112	Stock	1, 2, 4, 12	37N	5W
		33	38N	5W
113	Sylvester	1	37N	5W
	BARITE			
114	Afterthought	2	34N	4W
115	Glidden	18, 19	38N	3W
116	Hirz Mountain	12	35N	4W
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117	Barnes	4	33N	1W
118	Dakin	12	33N	2W
119	Kosk Creek	22	38N	1E
120	Luce	20	33N	1W
	DIATOMITE			
121	Cayton Creek group	17, 18, 19	37N	3E
122	Insulator group	19, 30, 31	37N	4E
		21, 22, 23, 24, 25, 26, 27, 36	37N	3E
		1, 12	36N	3E
		7	36N	4E
123	Sheep Springs	26, 35	37N	2E
	LIMESTONE			
124	Asher	1, 2	33N	2W
125	Briggsville	31	31N	5W
126	Brock Mountain	8	34N	2W
127	Calaveras Cement Company	2, 3, 9, 16	33N	4W
128	Emerald Glen	1	33N	2W
		6	33N	1W
129	Holt and Gregg	34	34N	5W
130	Shasta Iron Company	26	34N	4W
	MINERAL SPRINGS			
131	Big Bend Hot Springs	36	37N	1W
132	Castle Crag Spring	11, 12	38N	4W
133	Mountain Spring Water Company	6	31N	4W
	PUMICE, ETC.			
134	Black Butte	17	30N	1W
135	Doyle Butte	31	35N	4E
		6	34N	4E
136	Hackler	8	30N	1W
137	Horr	21	38N	4E
138	Maacooatche	9	34N	4E
139	Perk-O-Lite	23	36N	5E
140	Pit No. 1	35	37N	4E
		11	36N	4E
141	Potato Butte	17	32N	5E
142	Sanford	1	35N	4E
143	Stewart Masonry Supply	24	31N	5W
	SAND AND GRAVEL			
144	Anderson-Cottonwood Concrete Products	11	29N	4W
145	Anderson Creek	22	30N	4W
146	Carroll	36	35N	1W
147	Crowe	34	32N	2W
148	Dodson	11, 12	30N	4W
149	French Gulch	14	33N	7W
150	J. H. Hein Company	6	31N	4W
151	Oaks Sand and Gravel Company	30	31N	4W
152	Old Station	8	32N	5E
153	Rayner	25	37N	1W
154	Redding Sand and Gravel Company	31	32N	4W
155	Redding Transit Mix, Incorporated	6	31N	4W
156	Riley Trucking	18	32N	4W
157	J. F. Shea Company, Incorporated	30	31N	4W
	STONE, CRUSHED			
158	Bagula	13	33N	2W
159	Dubois	36	34N	2W
160	Fern	24	33N	1W
161	Grant	34	34N	1W
162	P. G. E.	36	37N	4E
163	Shasta Forests Company	36	39N	2E
	STONE, DIMENSION			
164	Jewel	25	31N	6W
165	Millville	18	31N	2W
166	Texas Spring	29	31N	5W
	TALC			
167	Ganim	5, 8	32N	6W

YANKEE JOHN GOLD MINE

SHASTA COUNTY, CALIFORNIA

SECTION 17, T 31 N R 5 W MDM

GEOLOGY BY W. J. WALKER
WALKER ENGINEERING CORP., MAY 1959
(compiled by Philip A. Lydon)

SCALE
0 30 60 90 FT

1972

Index map showing location of Yankee John Gold Mine, Shasta County, California

EXPLANATION

INTRUSIVE
- Andesite ("bird's eye") porphyry

COPELY GREENSTONE
- gs — Massive greenstone
- gs tuff — Arkosic, sondy, or tuffaceous greenstone
- Undifferentioted mefosediments, chert, orgillite, slofe

- Quartz veins
- Faults
- Bedding
- Foliation
- Joints